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(54) **Apparatus and method for controlling the transmission power of the forward link of a wireless communication system**

Vorrichtung und Verfahren zur Sendeleistungsregelung einer Vorwärtsverbindung in einem drahtlosen Übertragungssystem

Procédé et dispositif de commande de la puissance de transmission vers l'avant dans un système de communication sans fil

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- **KIM D: "FORWARD LINK POWER ALLOCATION FOR IS-95 BASED CDMA MOBILE SYSTEMS" ICC '99. 1999 IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS. CONFERENCE RECORD. VANCOUVER, CA, JUNE 6 - 10, 1999, IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS, NEW YORK, NY: IEEE, US, vol. 2, 6 June 1999 (1999-06-06), pages 1126-1130, XP000898032 ISBN: 0-7803-5285-8**

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Description

Background of the Invention

Field of the Invention

[0001] The present invention relates generally to wireless communication systems and, in particular, to power of the forward link in wireless communication systems.

Description of the Related Art

[0002] Wireless communication systems employ Code Division Multiple Access ("CDMA") modulation techniques to permit a large number of system users to communicate with one another. The ability of such a system to work is based on the fact that each signal is coded with spreading sequences, such as pseudorandom noise ("PN") sequences, and orthogonal spreading sequences such as Walsh codes. This coding permits signal separation and signal reconstruction at the receiver. In typical CDMA systems, communication is achieved by using a different spreading sequence for each channel. This results in a plurality of transmitted signals sharing the same bandwidth. Particular transmitted signals are retrieved from the communication channel by despreading a signal from all of the signals by using a known user despreading sequence related to the spreading sequence implemented at the transmitter.

[0003] Figure 1 illustrates CDMA system 10. The geographic area serviced by CDMA system 10 is divided into a plurality of spatially distinct areas called "cells." Although cells 2, 4, 6 are illustrated as a hexagon in a honeycomb pattern, each cell is actually of an irregular shape that depends on the topography of the terrain surrounding the cell. Each cell 2, 4, 6 contains one base station 12, 14, and 16, respectively. Each base station 12, 14, and 16 includes equipment to communicate with Mobile Switching Center ("MSC") 18, which is connected to local and/or long-distance transmission network 20, such as a public switch telephone network (PSTN). Each base station 12, 14, and 16 also includes radios and antennas that the base station uses to communicate with mobile terminals 22, 24.

[0004] When a call is set up in a CDMA system, a base station and mobile terminal communicate over a forward link and a reverse link. The forward link includes communication channels for transmitting signals from the base station to the mobile terminal, and the reverse link includes communication channels for transmitting signals from the mobile terminal to the base station. The base station transmits certain types of control information to the mobile terminal over a communication channel, referred to herein as a forward control channel, also known in the art as a forward overhead channel. Forward control channels include the pilot, paging, and synchronization channels, as well as other control channels. The base station transmits voice or data, and certain types of control information over a communication channel, referred to herein as a forward traffic channel. The signals on the communication channels are organized in time periods, referred to herein as frames. Frames are typically 20-millisecond (ms) in length. The signals transmitted over the control channels are referred to herein as control signals, and the signals transmitted over the traffic channels are referred to herein as traffic signals.

[0005] When a call is added to a cell, the noise level in the cell and in the surrounding cells is increased. If there is a large number of calls in a particular cell 4, it becomes difficult for mobile terminal 24 to clearly obtain the pilot and/or the forward-link traffic signal, particularly if mobile terminal 24 is at the edge of a cell. When mobile terminal 24 cannot obtain a clear and continuous pilot and/or the forward-link traffic signal, problems can result on the call between mobile terminal 24 and base station 14. These problems can range from not being able to despread a frame, which results in an erred frame, to the mobile terminal 24's user hearing noise or silence instead of the voice or data that was transmitted, which results in an inconvenience to the user. If mobile terminal 24 cannot obtain a clear and continuous pilot and/or the forward-link traffic signal for a prolonged period or time, such as several seconds, the call may be dropped, which results in an inconvenience to the user and a loss of revenue.

[0006] When cell 4 is heavily loaded with calls, base station 14's equipment may not be able to handle all of the calls in cell. This can occur when the power transmitted by the base station exceeds the power level at which the base station's equipment is designed to operate over an extended time period. In some wireless communication systems 10, when there are many calls base station 14 initiates overload control. Base station 14 implements overload control by using one of several remedies. These remedies typically include: a) denying access to any new call requests, referred to herein as call blocking; b) restricting transmitted signals to their current levels; or c) even clipping transmitted signals. The inventors have discovered that this could occur even when other cells 2 and 6, may be able to accept new calls. This situation results in a loss of capacity of the overall wireless communication system 10.

[0007] US-A-5,715,526 teaches an apparatus and method for controlling a final transmit power, y, of a base station in a cellular communications system that has several channels. The base station has a transmit power tracking gain, y', and a radio frequency transmit power, w. The apparatus comprises channel elements for calculating expected powers, $P_{k,a}$-$P_{k,i}$, each of which corresponds to a channel. The apparatus also comprises a transceiver system controller

(BTSC) for generating a desired output power, y_d, of the base station, including an adder for summing the expected powers. The apparatus also includes a transmit power detector for measuring y to obtain a measured transmit power. The apparatus further comprises a radio frequency interface card (RFIC) for generating y'. Finally, the apparatus includes a gain unit for processing y' and w to obtain the final transmit power, y.

[0008] EP-A-0887947 teaches a method of controlling transmission power of a plurality of base stations associated with a mobile unit in a CDMA cellular system. The mobile unit in the system communications with one base station among the plurality of base stations. Power of each of the pilot signals respectively transmitted from the plurality of base stations is measured at the mobile unit. Then information about a measured power value of each of the pilot signals is transmitted to the one base station. Thereafter, a first power control coefficient is determined at the one base station. The coefficient is a ratio of total pilot power values of the plurality of base stations, other than the main base station, to a pilot power value of the one base station. Subsequently, the transmission power of each of the plurality of base stations using the first power control coefficient is controlled.

[0009] Kim D *et al*: "Forward Link Power Control for CDMA Cellular Systems" IEICE Transactions on Communications, Institute of Electronics Information and Comm. Eng. Tokyo, JP, vol. E81-B, no. 6, 1 June 1998 (1998-06-01), pages 1224-1230, XP000788970 ISSN: 0916-8516 teaches a method for forward link power control for CDMA cellular systems in order to allocate available power to as many mobiles as possible. According to D3, pilot and traffic power are allocated according to the needs of the each cell. Pilot power control balances nonuniformly imposed loads throughout the network and, as a result, helps the network resources to be utilized equally.

Summary of the Invention

[0010] A method according to the invention is as set out in claim 1. Preferred forms are set out in the dependent claims.

[0011] The invention solves the above problems by adjusting the power level of a set of forward-link signals of a base station responsive to the loading of the forward link as determined by a power level measurement of the signal set. The power level of the signal set is adjusted independent of the individual power control of each of the forward-link signals in the set. Adjusting the power level of the signal set allows a cell that contains the base station to grow, i.e. cover a larger area, when the loading of the forward link is low. This allows a lightly loaded cell to accept calls from mobile terminals that may otherwise have been geographically constrained to a heavier loaded cell, thereby lightening the load in the heavier loaded cell. This also allows mobile terminals at the edge of cells to receive signals more clearly.

[0012] One power level measurement is a pilot fraction of the forward link, which is a ratio of the pilot's power level to the power level of the forward-link signals. Other power level measurements, such as the signal set's power level, can be used, alone or in combination, instead of or in addition to the pilot fraction of the forward link to adjust the power level of the signal set. Adjusting the power level of the signal set using several measurements involves determining how the power level of the signals set should be adjusted based on any of the power level measurements and adjusting the power level of the signal set when any one of the measurements indicates that the power level should be adjusted. Alternatively, the power level can be adjusted when several of the measurements indicate that the power level should be adjusted.

[0013] The power level of the set can be changed in any manner, including by scaling it by a scaling factor, or by increasing the power level by a fixed or a variable amount. The power level measurement of the signal set is obtained during a current time period. The scaling factor that will be used in the subsequent time period is determined using the power level measurement. In one embodiment of the invention, the scaling factor can be obtained from a look-up table that is based on the power level measurement.

[0014] If the cell containing the base station includes several sectors, the power level of the signal set in a sector is adjusted when the power level measurement in that sector indicates that the power level should be adjusted.

Brief Description of the Drawings

[0015]

Figure 1 is a block diagram of a portion of a conventional base station; and

Figure 2 is a block diagram of a portion of a base station where the power level of a set of forward-link signals is adjusted responsive to the loading of the forward link as determined by a pilot fraction.

Detailed Description

[0016] Figure 2 shows a portion of base station 200 that adjusts the power level of a set of forward-link signals of a base station responsive to the loading of the forward link as determined by a power level measurement of the forward link. The power level measurement used in base station 200 is a pilot fraction of the forward link, which is a ratio of

the pilot's power level to the power level of the set of forward-link signals of base station 200.

[0017] Although, in the illustrative embodiment base station 200 uses the pilot fraction to adjust the power level of the signal set, other power level measurements can be used, alone or in combination, instead of or in addition to the pilot fraction of the forward link to adjust the power level of the signal set. For example, the power level measurement can be the power level of the signal set.

[0018] Each of the base station's signals is the output of one of channel elements 210, 220. The channel elements encode the data with the spreading codes. The control signals are the outputs of control-channel channel elements 210, and the traffic signals are the output of traffic-channel channel elements 220. The output of all of the channel elements 210 and 220 is coupled to combiner 230 where all of the signals are combined together to form a combined-baseband signal. The signals are organized in frames, which, as described above, are typically 20-millisecond (ms) time periods. The instantaneous signal levels of the combined-baseband signal are measured throughout the current frame, and are then averaged in sample-square-integrate circuit 240. This averaged power level is referred to herein as the combined-baseband signal's power level for the current frame. The pilot's instantaneous signal levels are also measured throughout the current frame, and are then averaged in sample-square-integrate circuit 250. This averaged power level is referred to herein as the pilot's power level for the current frame. The combined-baseband signal's power level and the pilot's power level for the current frame are the input of first averaging element 260.

[0019] First averaging element 260 determines the current frame's ratio of the pilot's power level to the combined-baseband signal's power level, referred to herein as the current frame's pilot fraction PF[n]. First averaging element 260 determines the average pilot fraction avPF[n] using a single pole infinite impulse response (IIR) filter. The functionality of the IIR filter is described in equation 1. As shown in equation 1, the value of the average pilot fraction avPF [n] is based on the current frame's pilot fraction PF[n] scaled by λ, and the previous frame's average pilot fraction avPF [n] scaled by an adjustment factor based on λ. λ controls how rapidly the average pilot fraction avPF[n] changes in response to variations in the pilot fraction of the current frame PF[n]. λ is selected to balance a desire to obtain a pilot fraction that is as reflective as possible of the current frame's pilot fraction and a desire to have a smoothly varying power level. A typical value for λ can be between about 2 and 200.

$$avPF[n] = \frac{1}{\lambda} * PF[n] + \left(1 - \frac{1}{\lambda}\right) * avPF[n-1] \quad (1)$$

[0020] First averaging element 260 provides the current average pilot fraction avPF[n] to controller 270. Controller 270 obtains a look-up table from memory 280. The look-up table relates the average pilot fraction avPF[n] to scaling factor g[n+1]. Table 1 is an example of a look-up table that can be used. Controller 270 obtains scaling factor g[n+1] from the look-up table by determining the value in the look-up table to which the average pilot fraction avPF[n] is closest. When the pilot fraction is directly between two values listed in the table scaling factor g[n+1] can be chosen to be either the one associated with the greater or smaller value, although it is preferable to chose the smaller value to ensure that base station 200 can produce the required power level without straining its amplifier.

Table 1

Average Pilot Fraction	Scaling Factor
.78	1.5
.6	1.4
.5	1.3
.4	1.2
.3	1.1
.2	1
.1	.9

[0021] The scaling factors in the look-up table are chosen to adjust the power level of the signal set to maximize the capacity of the system without overloading base station 200's equipment. Preferably, a scaling factor of one is associated with the full load pilot fraction, which is the pilot fraction when the base station is at full load. Typically, the full

load pilot fraction is between 1 and .25. Also preferably, the largest scaling factor is associated with pilot-fraction at no load. At no load the base station is typically transmitting the pilot, page, and synch channels. The pilot fraction at no load is the ratio of the pilot's power level to the sum of power levels of the pilot, the paging channel, and the synch channel. The pilot fraction at no load is typically about .78.

[0022] When the signal set's power level is scaled by the scaling factor that increases the signal set's power level, then, typically, the forward-link coverage area of base station 200 also increase. This means after the power level of the signal set is scaled, the signals may be able to reach mobile terminals that the signal may not have been able to reach before. However, the forward-link traffic signals do not need to reach mobile terminals that the pilot does not reach. This is due to the fact that if a mobile terminal is not receiving the pilot it is not able to communicate with base station 200, and therefore there is no benefit in the mobile terminal receiving the signal. Therefore, the forward-link coverage area preferably does not exceed an area in which a mobile terminal at the edge of the area is able to receive the pilot.

[0023] After, controller 270 obtains scaling factor g[n+1], controller 270 provides the scaling factor as an input of multiplier 290. The other input of multiplier 290 is the combined-baseband signal, which is the output of combiner 230. Multiplier 290 multiplies the combined-baseband signal and scaling factor g[n+1] to scale the power level P[n+1] of the signal set during the subsequent frame. The power level of the signal set is scaled by scaling factor g[n+1], which is obtained using the average pilot fraction avPF[n] of the last frame. However, the delay between the frame whose pilot fraction is used to obtain the scaling factor, and the frame whose power level is scaled by the scaling factor can be made larger or smaller based on the speed of first averaging element 260 and controller 270. For example, if the circuitry of the first averaging element 260 and controller 270 is fast enough, or if the signals can be delayed until the scaling factor is obtained, the power level P[n] can be scaled by scaling factor g[n] obtained using the average pilot fraction avPF[n] of the current frame. The signal can be delayed by adding a pipeline delay between combiner 230 and multiplier 290.

[0024] Multiplier 290 multiplies the scaling factor and the combined-baseband signal that forms the subsequent frame, thereby scaling the power level P[n+1] of all of the signals by the same amount. The result is then input into modulator 300 where the signal is slightly amplified and is modulated onto a carrier signal. The modulated signal is amplified in amplifier 310 and then transmitted via the antenna 320 to the mobile terminals.

[0025] Although, in this embodiment the pilot fraction is the power level measurement used to obtain the scaling factor, in alternative embodiments other power level measurements, such as the power level of the signal set can be used, alone or in combination, instead of or in addition to the pilot fraction of the forward link to obtain the scaling factor. Therefore, similar look-up tables as the one described above can be obtained for other power level measurements. Determining the scaling factor using one of the other power level measurements is performed in a similar manner as for the pilot fraction.

[0026] Additionally, although, in this embodiment a look-up table is used to obtain the scaling factor, in alternative embodiments the scaling factor can be obtained in other ways.

[0027] The adjustments of the power level of the signal set described above are performed independent of the conventional individual power control of each of the traffic signals. Therefore, when the mobile terminal receives a traffic signal, in IS-95 compliant CDMA systems the mobile terminal checks to determine whether the received forward-link traffic frame is in error. In a subsequent reverse-link traffic frame that the mobile terminal transmits, the mobile terminal indicates to base station 200 whether there was an error. When the mobile terminal receives a traffic signal, in CDMA 2000 systems the mobile terminal checks to determine whether the received forward-link traffic signal has sufficient signal strength to overcome the noise in the system, typically by checking the forward-link traffic signal's signal-to-noise ratio. The mobile terminal then indicates to base station 200 whether the forward-link traffic signal strength is sufficient. Upon receiving from the mobile terminal the information of whether there was an error (in IS-95 compliant CDMA systems) or whether the forward-link traffic signal strength is sufficient (in CDMA 2000 systems) base station 200 determines whether its forward link to this mobile terminal is in fading. Base station 200 then adjusts the power level of the signal to the mobile terminal accordingly, prior to the signal being summed in combiner 230. Preferably, the individual power control of each of the signals includes a maximum power level above which the signal's power level is not allowed to go. If a signal's power level is at this maximum power level, and the mobile terminal receiving this traffic signal indicates to the base station to increase the power level of this signal the base station will not further increase the power level of this traffic signal. The maximum power level ensures that no signal is using a significantly disproportionate amount of power.

[0028] After base station 200 adjusts the power level of the signal to the mobile terminal, the signal is then combined with the signals from other traffic channels, and then, if necessary, scaled.

[0029] The method for adjusting the power level of the signal set based on the power level measurement of the signal set can be used with methods of overload control. For example, the method for adjusting the power level of the signal set can be used with the overload power control method disclosed in EP application no. 00305859.1.

[0030] This overload power control method changes the power level of a set of forward-link signals responsive to a

overload control threshold power level that is based on the amplifier's maximum continuous power level, independent of the individual power control of each of the forward-link signals in the signal set. The power level of the signal set is changed by scaling it by a scaling factor. The total power level of the signal set is obtained during a current time period, and then the scaling factor that will be used in the subsequent time period is determined. The scaling factor is preferably based on the total power level of the signal set for the current time period, a scaling factor used during the current time period, and the overload control threshold power level. The amount by which the total power level exceeds the amplifier's maximum continuous power level is the overload amount The scaling factor is selected so that for each time period the overload amount is reduced by a percentage or a fixed factor. For example, the overload amount can be reduced by 3% for the current time period, then the percentage may be changed for a subsequent time period based on the scaling factor of the current time period and the overload amount of the subsequent interval.

[0031] Additionally, the method for adjusting the power level of the signal set can be used with the method for initiating call blocking disclosed in EP application no. 00305850.0.

[0032] This method initiates call blocking responsive to a call-quality measurement of the forward link. The call-quality measurement is a measurement of how well a mobile terminal is able to receive the forward link. One call-quality measurement is the pilot fraction of the forward link. Call blocking can be initiated when the average pilot fraction is below a pilot-fraction blocking threshold. The pilot fraction is determined for the time period, and then used to determine an average pilot fraction for the time period. The average pilot fraction for the current time period is based on a pilot fraction for the current time period, and an average pilot fraction for a previous time period. When the average pilot fraction is below the pilot-fraction blocking threshold, call blocking is initiated. The pilot-fraction blocking threshold is preferably based on: 1) the pilot fraction when the base station is at full load; 2) the size, shape, and terrain of the cell; and 3) the aggressiveness of the overload control. In the preferred embodiment, the set includes all of the signals generated by the base station, alternatively, the set can include fewer than all the signals generated by the base station. For example, the set can include a plurality of traffic signals, or a plurality of traffic signals and one or more of the control signal. If the cell includes several sectors, the call blocking is initiated on a sector basis when the average pilot fraction of the sector is below the pilot-fraction blocking threshold.

[0033] The foregoing is merely illustrative. Thus, for example although in the illustrative embodiment the time period is one frame, any time period can be used during which a power level measurement of the forward link can be taken. For example, the time period can be several frames, or one or several power control groups, which are time periods having a length of 1/16 of a frame.

[0034] Furthermore, although in the illustrative embodiment all the signals in a sector of a cell containing the base station are scaled by the scaling factor, in an alternative embodiment fewer than all the signals in a sector can be scaled by the scaling factor. For example, the signal set can include a plurality of the traffic signals, or a plurality of the traffic signals and one or more control signals.

[0035] Still further, although in the illustrative embodiment the method is implemented in hardware, it can be implemented in software.

[0036] Additionally, although in the illustrative embodiment each cell is an omni sector cell, the cell can be divided into a plurality of sectors, with each sector having its own channel elements, radios, which include a modulator and an amplifier, and antennas. In this case, the power level measurement is taken on a per-sector basis and used to obtain a scaling factor. The power level of the signal set in a sector is adjusted when the power level measurement in that sector of the cell indicates that the power level should be adjusted.

[0037] Moreover, in one of the illustrative embodiments the average pilot fraction for the current time period is determined using an IIR filter. In an alternative embodiment a finite impulse response (FIR) filter can be used to determine the average pilot fraction. The FIR filter would use the pilot fraction for the current time period, and the pilot fractions of a plurality of frames, averaged over a plurality of frames.

[0038] Additionally, although in the illustrative embodiment the channel elements are shown in parallel, with the resulting signals combined in one combiner, the channel elements can be set up in series. In this case, the signal from each channel element is combined with signals from the previous channel elements in the series.

[0039] Furthermore, although in the illustrative embodiment the combined-baseband signal is scaled, in alternative embodiments the individual signals can be scaled. For example, the scaling factor is still obtained using the combined-baseband signal. However, instead of multiplying the combined-baseband signal by the scaling factor in multiplier 290 and 350, the scaling factor can be provided to control elements 210 and 220 where the individual signals can be scaled by the scaling factor.

[0040] Additionally, although in the illustrative embodiment the wireless communication system is a CDMA system, this should not be construed to limit the present invention to base stations and mobile stations employing CDMA techniques. The present invention may equally be applicable to base stations and mobile stations employing other multiple access techniques, such as Time Division Multiple Access ("TDMA"), and Global System for Mobile (GSM).

[0041] While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art having reference to the specification and drawings that various modifications and alternatives

are possible therein without departing from the scope of the invention.

Claims

1. A method for controlling a power level of signals transmitted by a base station (200) in a wireless system, the base station (200) having a signal set of forward link signals, the method comprising the steps of:

    obtaining a power level measurement of the forward link signal set; and
    adjusting the power level of the signal set responsive to the power level measurement wherein the obtaining step is **CHARACTERIZED BY**:

        obtaining a power level (P[n]) of the signal set for a time period;
        obtaining a power level of the pilot for the time period; and
        determining a ratio of the pilot's power level to the power level of the set of forward-link signals of the base station (PF[n])for the time period;
        and wherein the adjusting step comprises:

            determining a scaling factor based on a the pilot ratio of the pilot's power level to the power level of the set of forward-link signals of the base station (PF[n]); and
            scaling the power level of the signal set using the scaling factor.

2. The method of claim 1, **CHARACTERIZED IN THAT** a cell containing the base station (200) comprises a plurality of sectors, each corresponding to at least one signal set and wherein:

    the step of obtaining the power level of the signal set comprises obtaining a power level for each signal set for the time period;
    the step of determining the ratio of the pilot's power level to the power level of the set of forward-link signals of the base station comprises determining a pilot fraction for each signal set for the time period;
    the step of determining the scaling factor comprises determining a scaling factor for each signal set; and
    the scaling step comprises scaling the power level of each signal set using the scaling factor determined for that set.

3. The method of claim 1, **CHARACTERIZED IN THAT** determining the scaling factor comprises looking up the scaling factor in a look-up table that relates the ratio of the pilot's power level to the power level of the set of forward-link signals of the base station to the scaling factor.

4. The method of claim 1, **CHARACTERIZED IN THAT** the time period comprises a frame.

5. The method of claim 1, **CHARACTERIZED IN THAT** the time period comprises a plurality of frames.

6. The method of claim 1, **CHARACTERIZED IN THAT** the scaling step comprises scaling the power level of the signal set during a subsequent time period using the scaling factor.

7. The method of claim 1, **CHARACTERIZED IN THAT** the scaling step comprises scaling the power level of the signal set during the time period using the scaling factor.

Patentansprüche

1. Verfahren zum Regeln eines Leistungspegels von durch eine Basisstation (200) in einem drahtlosen System übertragenen Signalen, wobei die Basisstation (200) eine Signalmenge von Abwärtsstreckensignalen aufweist, mit folgenden Schritten:

    Beschaffen einer Leistungspegelmessung der Abwärtsstreckensignalmenge; und
    Einstellen des Leistungspegels der Signalmenge als Reaktion auf die Leistungspegelmessung, wobei der Schritt des Beschaffens durch folgendes **gekennzeichnet** ist:

Beschaffen eines Leistungspegels (P[n]) der Signalmenge für eine Zeitdauer;
Beschaffen eines Leistungspegels des Piloten für die Zeitdauer und
Bestimmen eines Verhältnisses des Leistungspegels des Piloten zu dem Leistungspegel der Menge von Abwärtsstreckensignale der Basisstation (PF[n]) für die Zeitdauer;
und wobei der Schritt des Einstellens folgendes umfaßt:

Bestimmen eines Skalierungsfaktors auf Grundlage des Verhältnisses des Leistungspegels des Piloten zum Leistungspegel der Menge von Abwärtsstreckensignalen der Basisstation (PF[n]); und
Skalieren des Leistungspegels der Signalmenge unter Verwendung des Skalierungsfaktors.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** eine die Basisstation (200) enthaltende Zelle eine Mehrzahl von Sektoren umfaßt, die jeweils mindestens einer Signalmenge entsprechen, und wobei:

der Schritt des Beschaffens des Leistungspegels der Signalmenge das Beschaffen eines Leistungspegels für jede Signalmenge für die Zeitdauer umfaßt;
der Schritt des Bestimmens des Verhältnisses des Leistungspegels des Piloten zum Leistungspegel der Menge von Abwärtsstreckensignalen der Basisstation das Bestimmen eines Pilotenbruchteils für jede Signalmenge für die Zeitdauer umfaßt;
der Schritt des Bestimmens des Skalierungsfaktors das Bestimmen eines Skalierungsfaktors für jede Signalmenge umfaßt; und
der Skalierungsschritt das Skalieren des Leistungspegels jeder Signalmenge unter Verwendung des für diese Menge bestimmten Skalierungsfaktors umfaßt.

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** Bestimmen des Skalierungsfaktors das Nachschlagen des Skalierungsfaktors in einer Nachschlagetabelle umfaßt, die das Verhältnis des Leistungspegels des Piloten zum Leistungspegel der Menge der Abwärtsstreckensignale der Basisstation mit dem Skalierungsfaktor in Beziehung bringt.

4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** die Zeitdauer einen Rahmen umfaßt.

5. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** die Zeitdauer eine Vielzahl von Rahmen umfaßt.

6. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der Skalierungsschritt das Skalieren des Leistungspegels der Signalmenge während einer nachfolgenden Zeitdauer unter Verwendung des Skalierungsfaktors umfaßt.

7. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der Skalierungsschritt das Skalieren des Leistungspegels der Signalmenge während der Zeitdauer unter Verwendung des Skalierungsfaktors umfaßt.

Revendications

1. Procédé de commande d'un niveau de puissance de signaux transmis par une station de base (200) dans un système sans fil, la station de base (200) possédant un groupe de signaux sur la liaison aller, le procédé comprenant les étapes :

d'obtention d'une mesure du niveau de puissance du groupe de signaux sur la liaison aller ; et
de réglage du niveau de puissance du groupe de signaux en réponse à la mesure du niveau de puissance, l'étape d'obtention étant **CARACTERISEE PAR** :

l'obtention d'un niveau de puissance (P[n]) du groupe de signaux pendant un certain intervalle de temps ;
l'obtention d'un niveau de puissance du signal pilote pendant un certain intervalle de temps ; et
la détermination d'un rapport entre le niveau de puissance du signal pilote et le niveau de puissance du groupe de signaux sur la liaison aller de la station de base (PF[n]) pendant un certain intervalle de temps ;
et l'étape de réglage comprenant :

la détermination d'un facteur d'échelle en fonction du rapport entre le niveau de puissance du signal pilote et le niveau de puissance du groupe de signaux sur la liaison aller de la station de base (PF

[n]) ; et
la mise à l'échelle du niveau de puissance du groupe de signaux à l'aide du facteur d'échelle.

2. Procédé selon la revendication 1, **CARACTERISE EN CE QU**'une cellule contenant la station de base (200) comprend une pluralité de secteurs, chacun correspondant à au moins un groupe de signaux, et dans lequel :

   l'étape d'obtention du niveau de puissance du groupe de signaux comprend l'obtention d'un niveau de puissance pour chaque groupe de signaux pendant l'intervalle de temps ;
   l'étape de détermination du rapport entre le niveau de puissance du signal pilote et le niveau de puissance du groupe de signaux sur la liaison aller de la station de base comprend la détermination d'une fraction de signal pilote pour chaque groupe de signaux pendant l'intervalle de temps ;
   l'étape de détermination du facteur d'échelle comprend la détermination d'un facteur d'échelle pour chaque groupe de signaux ; et
   l'étape de mise à l'échelle comprend la mise à l'échelle du niveau de puissance de chaque groupe de signaux à l'aide du facteur d'échelle déterminé pour ce groupe.

3. Procédé selon la revendication 1, **CARACTERISE EN CE QUE** la détermination du facteur d'échelle comprend la recherche du facteur d'échelle dans une table à consulter qui lie le rapport entre le niveau de puissance du signal pilote et le niveau de puissance du groupe de signaux sur la liaison aller de la station de base au facteur d'échelle.

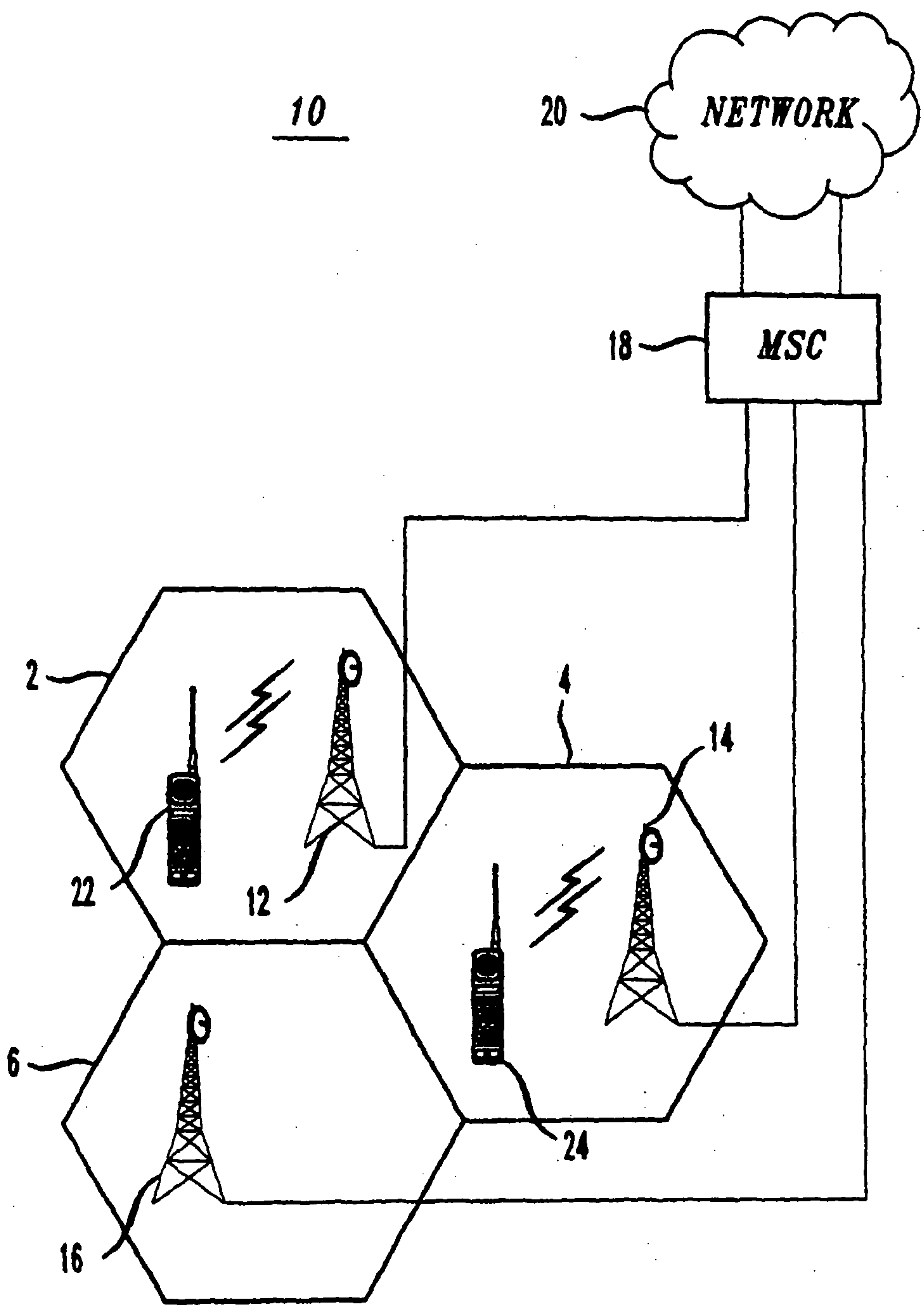
4. Procédé selon la revendication 1, **CARACTERISE EN CE QUE** l'intervalle de temps comprend une trame.

5. Procédé selon la revendication 1, **CARACTERISE EN CE QUE** l'intervalle de temps comprend une pluralité de trames.

6. Procédé selon la revendication 1, **CARACTERISE EN CE QUE** l'étape de mise à l'échelle comprend la mise à l'échelle du niveau de puissance du groupe de signaux durant un intervalle de temps ultérieur à l'aide du facteur d'échelle.

7. Procédé selon la revendication 1, **CARACTERISE EN CE QUE** l'étape de mise à l'échelle comprend la mise à l'échelle du niveau de puissance du groupe de signaux durant l'intervalle de temps à l'aide du facteur d'échelle.

FIG. 1
PRIOR ART



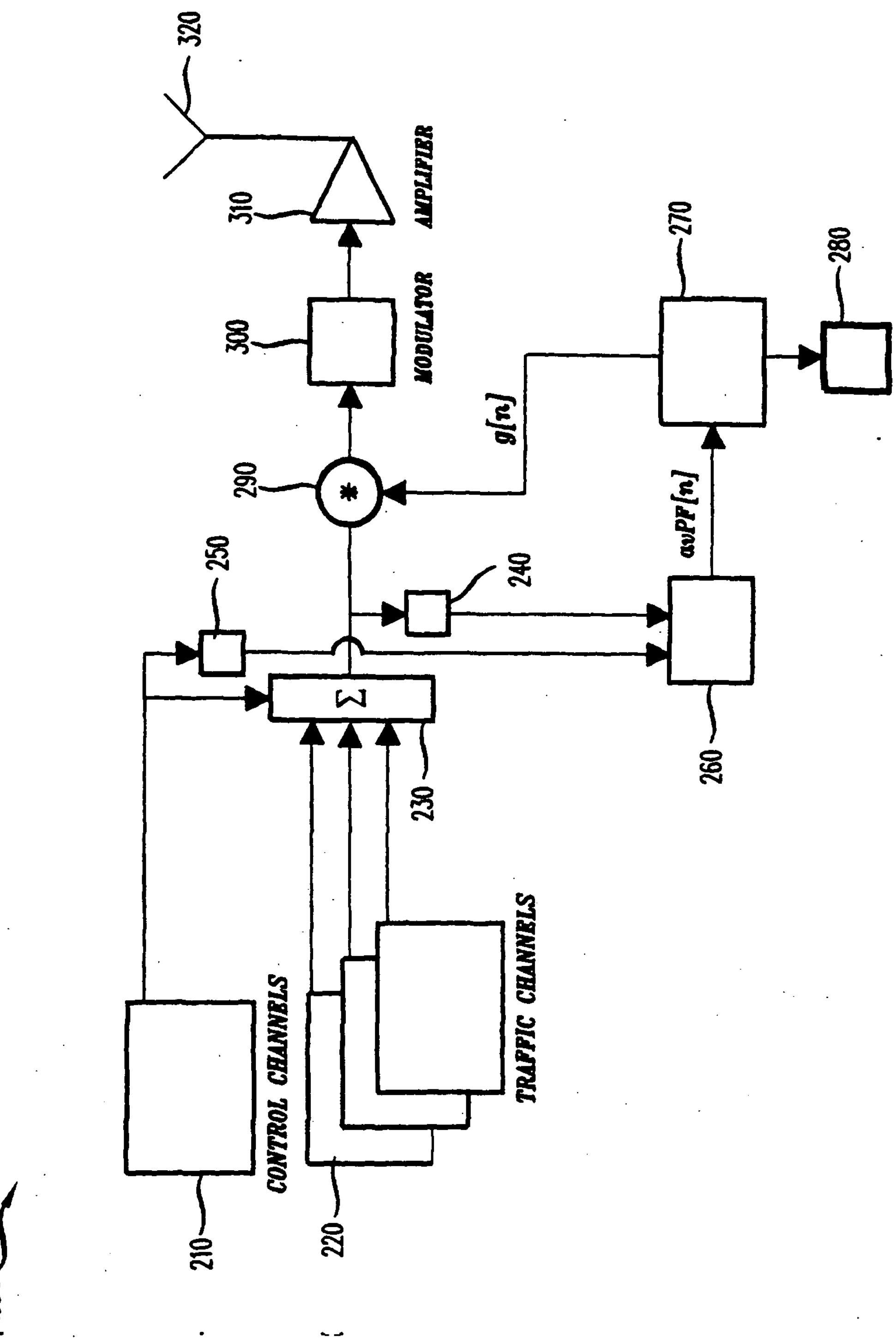

200
210
CONTROL CHANNELS
220
TRAFFIC CHANNELS
230
Σ
250
240
260
avPF[n]
290
*
g[n]
270
280
300
MODULATOR
310
AMPLIFIER
320

FIG. 2

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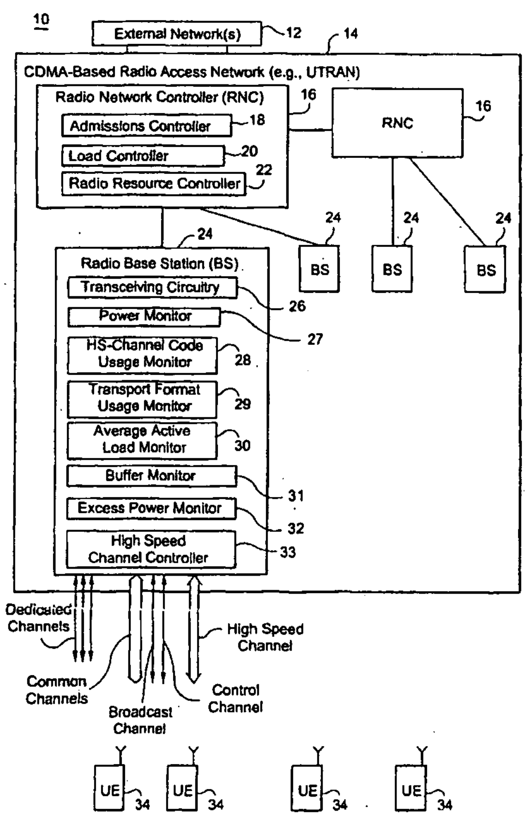
(54) Title: RADIO RESOURCE MANAGEMENT FOR A HIGH SPEED SHARED CHANNEL



(57) Abstract: Radio resources like spreading codes and transmission power are optimally allocated to various different types of radio channels supported in the cell including a specialized channel like a high-speed shared channel. One or more measurements made at the base station are provided to the radio resource manager. Such measurements include other-channel power, high speed shared channel code usage, high speed shared channel transport format usage, average active load on the high speed shared channel, empty buffer, excess power, and similar parameters that relate to a high speed shared channel. One or more of these reported measurements may then be used to access, allocate, and/or regulate resources associated with the base station's cell.

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RADIO RESOURCE MANAGEMENT FOR A HIGH SPEED SHARED CHANNEL

FIELD OF THE INVENTION

The present invention relates to radio communications, and more particularly, to radio resource management for a high speed shared channel.

BACKGROUND AND SUMMARY OF THE INVENTION

Third generation (3G) Universal Mobile Telephone communications Systems (UMTS), based on Wideband Code Divisional Multiple Access (WCDMA) radio access, provide wireless access at high data rates and support enhanced bearer services not realistically attainable with first and second generation mobile communication systems. A WCDMA radio access network, like the UMTS Terrestrial Radio Access Network (UTRAN), also enhances quality of service by providing robust operation in fading environments and transparent (soft/softer) handover between base station/base station sectors. For example, deleterious multipath fading is used to improve received signal quality with RAKE receivers and improved signal processing techniques.

Demand continues for improved multimedia communications in the UTRAN including higher peak data rates, lower radio interface delay, and greater throughput. A High Speed-Downlink Shared Channel (HS-DSCH) is standardized for use in WCDMA UTRAN networks to support higher peak rates on the order of 8-14 megabits per second. One of the ways the HS-DSCH achieves higher data speeds is by shifting some of the radio resource coordination and management responsibilities to the base station from the radio network controller, including one or more of the following briefly described below: shared channel transmission, higher order modulation, link adaptation, radio channel dependent scheduling, and hybrid-ARQ with soft combining.

Shared channel transmission and higher order modulation: In shared channel transmission, radio resources, like spreading code space and transmission power in the case of CDMA-based transmission, are shared between users using time multiplexing. A high speed-downlink shared channel is one example of shared channel transmission.

One significant benefit of shared channel transmission is more efficient utilization of available code resources as compared to dedicated channels. Higher data rates may also be attained using higher order modulation, which is more bandwidth efficient than lower order modulation, when channel conditions are favorable.

Link Adaptation and Rate Control: Radio channel conditions experienced on different communication links typically vary significantly, both in time and between different positions in the cell. In traditional CDMA systems, power control compensates for differences in variations in instantaneous radio channel conditions. With this type of power control a larger part of the total available cell power may be allocated to communication links with bad channel conditions to ensure quality of service to all communication links. But radio resources are more efficiently utilized when allocated to communication links with good channel conditions. For services that do not require a specific data rate, such as many best effort services, rate control or adjustment can be used to ensure there is sufficient energy received per information bit for all communication links as an alternative to power control. By adjusting the channel coding rate and/or adjusting the modulation scheme, the data rate can be adjusted to compensate for variations and differences in instantaneous channel conditions.

Channel Dependent Scheduling and Hybrid ARQ: For maximum cell throughput, radio resources may be scheduled to the communication link having the best instantaneous channel condition. Rapid channel dependent scheduling performed at the bases station allows for very high data rates at each scheduling instance and thus maximizes overall system throughput. Hybrid ARQ with soft combining increases the effective received signal-to-interference ratio for each transmission and thus increases the probability for correct decoding of retransmissions compared to conventional ARQ. Greater efficiency in ARQ increases the effective throughput over a shared channel.

Fig. 1 illustrates a high speed shared channel concept where multiple users 1, 2, and 3 provide data to a high speed channel (HSC) controller that functions as a high speed scheduler by multiplexing user information for transmission over the entire HS-DSCH bandwidth in time-multiplexed intervals. For example, during the first time

interval shown in Fig. 1, user 3 transmits over the HS-DSCH and may use all of the bandwidth allotted to the HS-DSCH. During the next time interval, user 1 transmits over the HS-DSCH, the next time interval user 2 transmits, the next time interval user 1 transmits, etc.

High-speed data transmission is achieved by allocating a significant number of spreading codes (i.e., radio resources in CDMA systems) to the HS-DSCH. Fig. 2 illustrates an example code tree with a fixed Spreading Factor (SF) of sixteen. A subset those sixteen codes, e.g., twelve, is allocated to the high-speed shared channel. The remaining spreading codes, e.g., four are shown in the figure, are used for other radio channels like dedicated, common, and broadcast channels.

Although not necessarily preferred, it is also possible to use code multiplexing along with time multiplexing. Code multiplexing may be useful, for example, in low volume transmission situations. Fig. 3 illustrates allocating multiple spreading codes to users 1, 2, and 3 in code and time multiplexed fashion. During transmission time interval (TTI) 1, user 1 employs twelve codes. During transmission time interval 2, user 2 employs twelve spreading codes. However, in transmission time interval 3, user 1 uses two of the codes , and user 3 uses the remaining ten codes. The same code distribution occurs in TTI=4. In TTI=5, user 3 uses two of the codes while user 2 uses the remaining codes.

To achieve higher throughput and high peak data rates, a high speed shared channel may not use closed loop power control, (as dedicated channels do), but instead simply uses the remaining power in the base station cell up to a preset maximum. Because the high-speed shared channel is used along with other channels, radio resources must be allocated to the different channels efficiently and without overloading the cell with too high of a power level. The power level for channels other than the high-speed shared channel must be managed to leave sufficient power for the shared channel to have the desired, high throughput.

The code assignment affects the throughput on the high-speed shared channel as well as the available code space for other channels. An optimal code

assignment depends on several factors, such as traffic load, the type of traffic, and current radio conditions. If too many CDMA codes are assigned to the high-speed shared channel, some of those codes may be underutilized, which is a waste of radio resources. If too few codes are assigned, the channel throughput over the high-speed shared channel is too low.

The radio network controller (RNC) performs radio resource management. Radio resources like spreading codes are allocated using one or more resource management algorithms. Other examples of such resource management include power/interference control, admission control, congestion control, etc. The radio network controller can better perform its resource management tasks if it knows the current resource status or use in the cell. One measurement useful to the radio network controller is how often the codes currently allocated to the high-speed shared channel are being used. The present invention provides measurements from the base station to the radio network controller about the usage of the set of codes currently allocated to a particular channel, like a high speed shared channel. Based on those measurements, the RNC can adjust (if necessary) the code allocation to the high speed shared channel.

Another managed radio resource that needs judicious allocation to different radio channels in a base station cell is radio transmission power level. Fig. 4 shows a graph of base station cell power against time. The radio transmission power for one or more common channels, shown in the bottom graph, takes up a first portion of the allowed or maximum cell power. On top of the common channel power is the combined radio transmission power currently allocated to the dedicated channels. The hatched portion shows the radio transmission power that can be used by the high-speed shared channel. At time t_m, the combined common and dedicated channel power equals the maximum cell power. As a result, the high speed shared channel has no available power, and therefore no throughput, assuming the maximum cell power level is observed. On the other hand, if the high speed shared channel uses more than the maximum cell power, signals may be distorted leading to degraded quality of service.

On request from the RNC base stations may provide measurements to the RNC, e.g., channel quality estimates for rate selection. But such base station measurements do not take into account the special nature of a high-speed downlink shared channel (HS-DSCH). Indeed, one typical base station measurement provided to the RNC is total transmitted carrier power for all downlink channels. That measurement would include the transmission power for the high-speed shared channel. Including the high-speed downlink shared channel in the total transmitted carrier power measurement presents a problem. First, the HS-DSCH, by design, typically uses all of the remaining transmission power up to the cell maximum. Second, the RNC uses the total transmission power measurement to decide whether to set up new dedicated radio channels. Consequently, the RNC will always conclude that the cell is operating at full capacity as long as there is a moderate traffic demand on the high-speed downlink shared channel. For the same reason, channel requests will be denied as soon as there is even moderate traffic demand on the high-speed downlink shared channel. Nor is it possible in this situation to determine an accurate congestion level in the cell. Because the high speed shared channel uses the remaining cell power, the total carrier power measurement will always be equal or close to the cell maximum erroneously suggesting that the cell is always fully loaded.

The present invention provides a cell transmission power measurement to a radio resource manager that specifically takes into account a high-speed shared channel even where that channel is designed to use the remaining transmission power in a cell up to a cell maximum. The radio network controller is informed when a high speed shared channel has little or no power available because of increasing power demands required by channels other than the high speed shared channel. Other parameters may also be measured at the base station that may be useful to a radio resource controller.

One or more base station measurements provided to a radio resource manager allows it to optimally access, allocate, and/or regulate radio resources, like spreading codes and transmission power, to different types of radio channels supported in the cell, including a specialized channel like a high-speed shared channel. Such

measurements include one or more of the following: other-channel power, HS-DSCH code usage, transport format usage, average active load, empty buffer, excess power, and/or similar parameters.

In one example embodiment, transmission power is measured for signals transmitted over first radio channels that do not include measurement of a transmission power for signals transmitted over a second radio channel, e.g., a high speed shared channel. CDMA code usage may also be measured for the second channel during a predetermined time period. One or both of the measured transmission power and the measured CDMA code usage are reported to a radio resource controller which may take appropriate resource management action(s). In a preferred example, the first and second channels are downlink radio channels from the CDMA mobile communications network to one or more of the mobile radios. The first radio channels include one or more of the following: one or more dedicated channels, one or more common channels, one or more control channels, and one or more broadcast channels. The second channel is a high speed downlink shared channel.

The measured transmission power may be used to perform radio resource control such as power allocation to the second radio channel and/or the first radio channels, code allocation to the second radio channel and/or first radio channel, congestion control, and admission control. The measurement also alerts the radio resource controller to situations where the power being used by the other channels leaves insufficient or rapidly decreasing power for the HS-DSCH. The radio resource controller may take appropriate action to reallocate power resources to ensure there is sufficient power for the HS-DSCH to function.

Using the measured CDMA code usage information, a determination may be made whether CDMA codes currently allocated to the second radio channel are being efficiently used. If not, the current CDMA code allocation for the second radio channel is changed. In one implementation, the predetermined time period includes plural transmission time intervals (TTIs). The number of TTIs that a CDMA code is used for the second radio channel during the determined time period is measured. Alternatively, a

number of TTIs that a set of the CDMA codes is used for the second radio channel during the predetermined time period may be measured. The CDMA code usage measurement may be reported in any number of fashions. In one example, the code usage is reported to the resource manager as a histogram.

Other example base station measurements may be used alone or in combination with each other and/or those measurements described above. For example, a number of mobile radio users may be measured that currently have data to transmit over the high speed shared channel in a base station buffer at a data transmission scheduling time for the high speed shared channel. The measured number corresponds to an active load and is provided to a radio network controller for use in managing a load on the high speed shared channel. A buffer monitor may be used to measure an amount of data being buffered per high speed shared channel user. A number of high speed shared channel transmission time intervals (TTIs) is determined over a measurement period when the measured amount of buffered data reaches zero or is below a threshold. The measured number can be used to (re)configure the high speed shared channel. An excess power monitor may be used to measure a first power level actually used for transmission to a mobile radio user over the high speed shared channel and determine a second power level required for reliable transmission to the mobile radio user over the high speed shared channel. The difference between the first and second power levels is calculated and used in allocating resources associated with the high speed shared channel.

The present invention enables efficient radio resource management without excessive signaling. By accounting for the specific characteristics of a particular type of channel, like a high-speed shared channel, one or more measurements in accordance with the present invention permits an accurate estimate of current cell conditions. As a result, a radio resource manager can better control cell congestion, admit new users to the cell, block new users, or even drop existing users, if necessary. Actions can be taken to ensure that maximum power limitations are not exceeded before the maximum power is reached which would otherwise result in unpredictable signaling distortion and poor signal quality. Moreover, the invention allows the radio resource controller to ensure the high-speed shared channel has enough resources to fulfill its job as a high-speed shared channel. Since

spreading codes are a limited resource in a CDMA system, an optimal code allocation is assured to various channels, which is particularly advantageous for a high-speed shared channel. Proper code allocation to a high-speed shared channel ensures optimal performance of that channel without under-utilizing or otherwise wasting radio resources.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features, and advantages of the present invention may be more readily understood with reference to the following description taken in conjunction with the accompanying drawings.

Fig. 1 illustrates conceptually a high speed downlink shared channel;

Fig. 2 illustrates a code tree;

Fig. 3 illustrates a time division code division multiplex diagram in conjunction with the high speed downlink shared channel;

Fig. 4 is a cell power diagram;

Fig. 5 is a function block diagram illustrating one example embodiment of the present invention in the context of a mobile radio communications system;

Fig. 6 is a flowchart diagram illustrating radio resource management procedures for a high-speed shared channel in accordance with one example embodiment of the present invention;

Fig. 7 is flowchart illustrating example other channel power measurement procedures;

Fig. 8 is a block diagram illustrating one way to perform other channel power measurement;

Fig. 9 is a flowchart illustrating example code resource measurement procedures;

Fig. 10 illustrates a code usage/transport format usage measurement;

Fig. 11 is a graph illustrating certain base station measurements;

Fig. 12 is a flowchart illustrating example average active load measurement procedures;

Fig. 13 is a flowchart illustrating example empty buffer measurement procedures; and

Fig. 14 is a flowchart illustrating example excess power measurement procedures.

DETAILED DESCRIPTION

In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular embodiments, procedures, techniques, etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. For example, while the present invention is described in an example application to a CDMA-based cellular system that uses a high-speed downlink shared channel, the present invention may be employed in any cellular system having different types of channels.

In some instances, detailed descriptions of well-known methods, interfaces, devices, and signaling techniques are omitted so as not to obscure the description of the present invention with unnecessary detail. Moreover, individual function blocks are shown in some of the figures. Those skilled in the art will appreciate that the functions may be implemented using individual hardware circuits, using software functioning in conjunction with a suitably programmed digital microprocessor or general purpose computer, using an application specific integrated circuit (ASIC), and/or using one or more digital signal processors (DSPs).

The present invention finds advantageous, but still example, application to a CDMA mobile communications network such as that shown at reference numeral 10 in Fig. 5. Plural external networks 12 are coupled to a CDMA-based radio access network 14 which, for example, may be a UMTS Terrestrial Radio Access Network (UTRAN). The UTRAN 14 includes one or more radio network controllers (RNC) 16 which communicate over a suitable interface. Each RNC 16 may include, among other things, an admissions controller 18, a cell load controller 20, and radio resource controller 22. Each of the controller entities may be implemented in hardware, software, or a combination of both. Each RNC 16 is coupled to plural radio base stations (BS) 24. Each radio base station 24 includes, among other things, radio transceiving circuitry 26, one or more transmit power monitors 27, a high speed channel code usage monitor 28, a transport format usage monitor 29, average active load monitor 30, empty buffer monitor 31, excess power monitor 32, and a high speed channel controller 33. The radio base station 24 communicates over a radio interface with various mobile stations identified as user equipments (UE) 34. Communications over the radio interface are made using spreading codes, i.e., one or more spreading codes corresponds to a radio channel.

System 10 includes different types of radio channels: one or more dedicated channels, one or more common channels, one or more broadcast channels, and a high speed shared channel such as a high speed downlink shared channel (HS-DSCH). Although an HS-DSCH is used in the examples below, the invention is not limited to HS-DSCHs. Base station 24 has a particular number of spreading codes available for use. See the example code tree with a spreading factor of 16 shown in Fig. 2. A certain number of the available spreading codes will be allocated to the high speed downlink shared channel, and the remaining codes are allocated to the other channels. The present invention strives to allocate the optimal number of spreading codes to the high speed downlink shared channel and to the other channels. The optimal allocation ensures that a desired data rate, throughput, and/or quality of service is/are provided over the high speed downlink shared channel while efficiently using all of the codes allocated to the high speed downlink shared channel. The high speed channel code usage monitor 28 provides the RNC 16 with actual

spreading code usage for the high speed downlink shared channel over a predetermined period of time.

Similarly, each base station cell is assigned a maximum downlink radio transmission power level. Transmission power is distributed amongst the various channels in the cell. In the power distribution shown in Fig. 4, the common channels use a certain transmission power, the dedicated channels are allocated transmission power on top of the common channel power, and the high speed channel uses whatever transmission power remains up to the maximum power established or some other predefined limit for that cell.

The high speed channel controller 32 may perform the various functions described above for a high speed downlink shared channel such as shared channel transmission, higher order modulation, link adaptation, radio channel dependent scheduling, and hybrid-ARQ with soft combining. Particularly, the high speed channel controller 32 controls fast scheduling of transmissions (and retransmissions) over the high speed downlink shared channel in each transmission time interval (TTI). The high speed controller 32 preferably allocates all of the codes allocated to the high speed downlink channel, e.g., twelve codes in the code tree of Fig. 4, to a single mobile radio UE connection in one TTI. But if the payload is insufficient for a single UE connection, or if the UEs are low-end UEs, code division multiplexing may also be employed by the radio resource controller 22 as explained above with regard to Fig. 3. For the admissions controller 18 to perform admissions control, the load controller 20 to perform load control, and the radio resource controller 22 to optimally manage radio resources in each cell, the RNC 16 must receive relevant and accurate measurement information from the base station 24.

In a first general example embodiment, one or more measurements are made and reported by the base station and used by a resource controller, which in this non-limiting example, is located the RNC. Refer to the Radio Resource Management for a High Speed Downlink Shared Channel procedures shown in flowchart form in Fig. 6. In the first step (block 40), the base station measures one or more of the following parameters: "other" channel power (other than HS-DSCH channel power), a HS-DSCH

code usage, transport format usage, average active load, empty buffer, and excess power. Each of these example base station measurements is described below. However, it should be understood that these measurements are only examples, and that the present invention is not limited to any one or combination of these specific measurements.

The base station sends to the RNC one or more of the base station measurements, and the resource controller 22 in the RNC uses that measurement information to perform power allocation and perhaps power control on the dedicated channels based upon the reported measurements. It also adjusts spreading code allocation adjustments based upon the reported measurements. The admissions controller 18 uses these measurements as a factor in determining whether to admit new call requests. The load controller 20, with this same information, determines whether congestion/load control is required in this cell (block 42).

Other Channel Power: Other channel power is transmission power attributable to transmissions made over one or more channels other than the high speed downlink shared channel. In this example, it includes the power of all channels but the high speed downlink shared channel. These channels may include, for example, one or more dedicated channels dedicated to a connection between the UTRAN 14 and the UEs 34, one or more common channels shared by the mobile radios, one or more control channels, and one or more broadcast channels. Other channel power may be measured by the power monitor 27 in the example manner described in conjunction with Fig. 8.

Example Other Channel Power Measurement procedures are illustrated in flowchart form in Fig. 7. The total power of all (or only some) downlink channels from the base station is measured with the exception of the transmission power of the high speed downlink shared channel (block 50). The total power measurement(s) is(are) forwarded to the RNC and used by one or more resource controllers like the radio resource controller 22, the load controller 20, and the admission controller 18 (block 52). Based on the measurements, the RNC (or the base station) determines the total power for the downlink channels except the high-speed downlink shared channel (block 54). If this power exceeds the threshold where there is not sufficient with power remaining for the

high-speed downlink channel the RNC may take various actions to limit the power needed for other down link channels. Such actions could consist of switching dedicated channels to a lower rate, e.g., congestion control, and/or admission control.

The transmitted signal is the sum of the signals from all individual physical channels, including common physical channels, dedicated physical channels, and shared physical channels (in particular the high-speed shared physical channel). The preferred, example implementation is to sum all signals except from the high-speed shared physical channel(s). The other channel power is measured by taking the average of the squared chip magnitudes of the signal sum. The signal to be transmitted is formed by adding the HS-DSCH signal to that signal sum.

Alternatively, the power measurement can be formed as a sum of several individual power measurements made on individual channel signals, or on sums of subsets of non-shared channel signals. This can be advantageous if the summing of the signals in an implementation must be done in a certain order different from the one described above. Individual power measurements are made by averaging the squared chip magnitudes of the individual channel signals or of the subsets.

If the individual power measurements are performed on individual channel signals (and not on subsets), the power measurements may be generated more easily based on knowledge of the configured transmission power and the current usage of each channel. The measured power value of an individual channel signal is then formed as the product of the squared gain factor for that signal and the activity factor for that channel. The activity factor is the ratio of the number of actually transmitted symbols to the total number of symbols.

Fig. 8 shows one example way in which other channel power may be measured at the base station. In this case, the other channels include dedicated physical channels (DPCH) 1, 2, …, N and a common channel (CC). Each other channel signal is multiplied in a corresponding multiplier 60, 62, 64, and 66 by an appropriate gain or power control (PC) value chosen according to the power control commands for that specific channel. The power control commands signaled from the UE to inform the base station

what power is needed for keeping specified signal quality for that specific channel. The power controlled and the common channel signals are summed together in summer 68, and the total power is determined in power detector 70 by taking the average of the squared chip magnitudes of the signal sum. Each chip in a spreading code has an I and a Q component so that its power $= \sqrt{I^2 + Q^2}$. The measured power of an individual channel signal may be determined as the product of the squared gain or power control (PC) factor for that signal and an activity factor for that channel, defined above. As an alternative mentioned above, subsets of the non-shared channel signals can be summed.

The total other channel power is provided to the RNC as indicated. The total other channel power is also summed in a summer 74 with the power of the high speed downlink shared channel. Although the HS-DSCH is not power controlled in the same manner as dedicated channels, the power must be set according to the power needed for other channels. Because the HS-DSCH uses the remaining power, which varies over time, the HS-DSCH power also varies. Thus, the PC factor for the HS-DSCH depends on the measured, non-HS-DSCH power. The sum of all downlink channels including the HS-DSCH is processed in the signal and radio processing block 76 and transmitted via antenna 78.

<u>HS-DSCH Code Usage/Transport Format Usage:</u> The high speed channel code usage monitor 28 measures the HS-DSCH code usage over a predetermined time period. A code resource/transport format usage measurement procedure is illustrated in flowchart form in Fig. 9. For each high speed downlink shared channel transmission time interval (TTI), e.g., two milliseconds, a transport format is selected by the high speed channel controller 33. The transport format specifies a particular number of spreading codes up to the allocated number of codes for use by the high speed downlink shared channel (block 80). The high speed channel controller 33 may also decide not to transmit over the high speed downlink shared channel during a TTI which would correspond to using zero spreading codes. Over a predetermined time period, such as 100 milliseconds, the high speed channel code usage monitor 28 measures a number of transmission time intervals (TTIs) that each spreading code is used by the high speed downlink shared

channel. Alternatively, the monitor 28 may measure a number of TTIs that each particular set of codes is used by the high speed downlink shared channel (block 82). An example of the latter might be that a set of codes including codes 1 through 6 is used in only two TTIs. A set of codes including just codes 1 and 2 is used in twenty-five TTIs. A transport format usage monitor 29 may additionally or alternatively measure a number TTI's that each transport format is used.

The code usage data detected by the monitor 28 and/or the transport format usage data detected by the monitor 29 for the predetermined time period is provided to the RNC. In one non-limiting example, the code usage information and/or the transport format usage data may be delivered in the form of a usage histogram. The radio resource controller (RRC) 22 in the RNC 16 determines whether to change the code allocation for the high speed downlink shared channel based on that code usage data or the transport format based on that transport format usage data (block 84).

Fig. 10 gives an example histogram mapping spreading codes 1 through 12 allocated for each two millisecond TTI for the high speed downlink shared channel, the high speed channel controller 32 selects a transport format. Of course, the entire histogram need not be sent over the radio interface but some abbreviated form of the histogram information could be transmitted instead. The code usage measurement need not include all possible number of codes. Alternatively, the number of times any subset of codes is used, for example 0-3, 4-7, 8-11, 12-15, etc., may be measured. As another alternative, the proportion of HS-DSCH TTI's for each code subset may be measured, or the time or proportion of time that each code subset is used.

The HS-DSCH code usage measurement may be generalized and expressed statistically as a function of the transport formats used. Based on certain available information, such as buffer status, channel conditions, available power resources, etc., the high speed channel controller 33 selects one of the transport formats. During a defined time interval, the base station transport format usage monitor 29 counts the number of times each transport format is used for the HS-DSCH. The result is a two-dimensional histogram describing for each transport format the number of times this transport format

is used. The measurement can either be the two-dimensional histogram or a function thereof.

Figure 11 illustrates an example of forming statistics over the set of possible transport formats. The numbers shown in the graph represent the transport block size (payload). The x-axis is the number of spreading codes used for the HS-DSCH. The y-axis represents the signal-to-noise ratio required for transmission expressed as a carrier-to-interference (C/I) ratio. The dotted line exemplifies a group of transport formats and is described in the text.

In a preferred, example embodiment, groups of transport formats are defined and only the number of times any transport format within this group is used is reported. In Fig. 11, a dotted line illustrates an example of such a group of transport formats including for each number of spreading codes, the transport format with the largest payload. Frequent use of transport formats in this group indicates the HS-DSCH is limited in the number of spreading codes rather than in the available energy. If possible, the RNC should assign more spreading codes to the HS-DSCH in order to increase its capacity.

As an alternative to reporting the number of times each group is used, the fraction of TTIs in each transport format group can be measured or the proportion of time that each transport format group is used. A relative measurement, e.g., the number of times one transport format group is used in relation to another transport format group, may be used. Furthermore, the statistics may be collected and reported individually for several data streams with different priorities. Individual statistics for each priority level used for packet data streams for the HS-DSCH are reported. In this situation, the RNC may be configured to act only on measurements for streams for which it wants to guarantee a certain quality of service.

Average Active Load: The active load for the HS-DSCH at a certain time instant is the number of users the high speed channel controller 33 can select between at that time instant. As indicated in the average active load measurement flowchart shown in Figure 12, the average active load monitor 30 detects a number of users currently having

data to transmit over the HS-DSCH at the time of the scheduling decision (block 90). For example, if 20 users have data to transmit over the HS-DSCH in the base station buffers at the time when the high speed channel controller 33 makes a scheduling decision, i.e, selects to which user(s) to transmit to, the active load at this time is 20. There could be more users than the active load actually assigned to the HS-DSCH, but it is only those users currently having data in the base station buffers that are included in the active load. The detected numbers collected over a preset time interval are averaged (block 92) and provided to the RNC (block 94). The average active load can be used for admission control, for example, to block users requesting an HS-DSCH if the average active load exceeds a certain limit. Admitting them in this situation would excessively degrade the overall performance of the HS-DSCH. As the transport format measurements described above, the average active load can be defined per priority level.

Empty Buffer: At each scheduling instant, the high speed channel controller 33 selects a suitable transport format, including the payload size, for the user(s) assigned to the HS-DSCH for the upcoming TTI. The payload size depends on the radio channel quality, i.e., a higher (lower) channel quality supports a larger (smaller) payload, and on the amount of data available in the base station buffers. Referring to the flowchart of Figure 12, the buffer monitor 31 detects an amount of data being buffered per HS-DSCH user for transmission (block 100). The amount of buffered data awaiting transmission for a certain UE forms an upper limit for the payload size, and thus, for the transport format selected. If the transport format is dictated by the data in the buffers rather than by the radio channel conditions, the HS-DSCH is underutilized, and the system is traffic-limited rather than limited by the radio environment. This situation may also indicate a need for more code multiplexing, (e.g., configuration of additional HS-shared control channels), especially if the transport format statistics described above indicate that transport formats with small payloads are used frequently. The buffer monitor 31 determines the empty buffer measurement as the number of TTIs in a defined measurement interval where less data was transmitted than would have been transmitted if the user's data buffer had not been emptied of if the amount buffered is less than a threshold amount (block 102). The empty buffer measurement can either be defined for all traffic regardless of priority, or it

can be defined individually per priority level. The empty buffer measurement is provided to the RNC for use, for example, in reconfiguring transport format, code allocation, etc., for the HS-DSCH (block 104).

Excess Power: Excess power is the difference between the power actually used for a transmission to a user and the power required for sufficiently reliable transmission that user with the selected transport format. As shown in the flowchart in Figure 14, the excess power monitor 32 detects power actually used for transmission to a user over the HS-DSCH (block 110). The excess power monitor 32 detects the power required for reliable transmission to that user over the HS-DSCH (block 112) and determines the difference (block 114). If the difference is positive, the excess power monitor 32 sends the excess power to the RNC for possible allocation of more radio resources, e.g., spreading codes, to the HS-DSCH.

An excess power example is illustrated in the graph shown in Figure 11. The lower circle represents the transport format selected at a certain scheduling instant, and the upper circle represents the power actually used for the transmission with the selected transport format. In the example, the excess power is 4 dB. Preferably, the excess power measurement is the average excess power used during a defined measurement time interval, e.g., 100 ms. A high excess power measurement indicates that the HS-DSCH is not operating in the power-limited region. Power can be used more efficiently by assigning more spreading codes to the HS-DSCH.

As an alternative to specifying a single excess power measurement for the HS-DSCH, the excess power measurement may be defined per transport format or per transport format group. The transport format statistics described above can be used to generate "transport format and resource usage" statistics. So in addition to counting the number of times a certain transport format is used, the average excess power for this transport format is also recorded.

While the present invention has been described with respect to particular embodiments, those skilled in the art will recognize that the present invention is not limited to these specific exemplary embodiments. Different formats, embodiments, and

adaptations besides those shown and described as well as many variations, modifications, and equivalent arrangements may also be used to implement the invention. Therefore, while the present invention has been described in relation to its preferred embodiments, it is to be understood that this disclosure is only illustrative and exemplary of the present invention. Accordingly, it is intended that the invention be limited only by the scope of the claims appended hereto.

WHAT IS CLAIMED IS:

1. A method for a mobile communications network supporting mobile radio communication using plural radio channels associated with a radio base station including first radio channels and a high speed shared radio channel, characterized by:

the radio base station measuring one or more parameters that affect management of the radio channels;

the radio base station reporting one or more of the measured parameters to a radio resource controller; and

the radio resource controller using the measured parameters to efficiently use radio resources associated with the high speed shared radio channel or the first radio channels.

2. The method in claim 1, wherein the base station measures an other transmission power for signals transmitted over the first radio channels that do not include a measurement of a transmission power for signals transmitted over the high speed shared radio channel, and

wherein the radio resource controller uses the other transmission power measurement to regulate a power level associated with one or more of the first radio channels or the high speed shared radio channel.

3. The method in claim 2, further comprising:

the radio resource controller performing admission and congestion actions in order to limit the power consumed by other channels than the high speed shared radio channel based on the measured transmission power so that sufficient power remains for the high speed shared channel.

4. The method in claim 1, wherein the communications are code division multiple access (CDMA) based,

wherein the base station measures a CDMA code usage for the high speed shared radio channel during a predetermined time period, and

wherein the radio resource controller uses the CDMA code usage to regulate CDMA code allocation to one or both of the first radio channels and the high speed shared radio channel.

5. The method in claim 4, wherein the predetermined time period includes plural transmission time intervals (TTIs), the method further comprising:

measuring a number of TTIs a CDMA code is used for the high speed shared radio channel during the predetermined time period or a number of TTIs a set of the CDMA codes is used for the high speed shared radio channel during the predetermined time period.

6. The method in claim 5, wherein the CDMA code usage is reported by the base station as a histogram or by some triggering criterion.

7. The method in claim 1, wherein the base station measures a transport format usage for the high speed shared radio channel during a predetermined time period, and

wherein the radio resource controller uses the transport format usage to regulate CDMA code allocation to one or both of the first radio channels and the high speed shared radio channel.

8. The method in claim 1, wherein the base station measures a number of mobile radio users currently having data to transmit over the high speed shared channel in a base station buffer at a data transmission scheduling time for the high speed shared channel and provides the number as an active load measurement for the high speed shared channel to the radio network controller, and

wherein the radio resource controller uses the active load measurement in controlling the base station.

9. The method in claim 1, wherein the base station measures an amount of data being buffered per high speed shared channel user, determines a number of high speed shared channel transmission time intervals (TTIs) over a measurement period when

the measured amount of data does not keep its corresponding buffer loaded with data, and provides the number of TTIs to the radio network controller, and

wherein the radio resource controller uses the number of TTIs in performing one or more radio resource operations.

10. The method in claim 1, wherein the base station measures a first power level actually used for transmission to a mobile radio user over the high speed shared channel, determines a second power level for reliable transmission to the mobile radio user over the high speed shared channel, determines the difference between the first and second power levels, and provides the difference to the radio network controller, and

wherein the radio resource controller uses the difference in performing one or more radio resource operations.

11. The method in claim 1, wherein the first radio channels and the high speed shared channel are downlink radio channels from the mobile communications network to one or more of the mobile radios,

wherein the first radio channels include one or more of the following: one or more dedicated channels dedicated to a connection between the mobile communications network and one of the mobile radios, one or more common channels shared by the mobile radios, one or more control channels, and one or more broadcast channels.

12. The method in claim 1, further comprising:

the radio resource controller using the measured parameters to perform one or both of congestion control and admission control.

13. A radio base station (24) for use in a mobile communications network (10) that supports radio communications with plural mobile radios (34), wherein first radio channels and a high speed shared radio channel are associated with the radio base station (24), characterized by:

one or more detectors (27-32) for measuring one or more parameters that affect management of the high speed shared radio channel, the radio base station (24) being

configured to report one or more of the measured parameters to a radio resource controller (22), and

a high speed shared channel controller (33) for using information from the radio resource controller (22) based on the measured one or more parameters to efficiently use radio resources associated with the high speed shared radio channel.

14. The radio base station in claim 13, wherein the one or more detectors (27-32) includes an other power detector for measuring an other transmission power for signals transmitted over first radio channels that do not include a measurement of a transmission power for signals transmitted over the high speed shared radio channel.

15. The radio base station in claim 14, wherein the high speed shared channel controller (33) is configured to allocate a power level for the high speed shared radio channel so that when the allocated power level is combined with the other power measured for the first radio channels, the combined power level does not exceed a predetermined maximum power level associated with the base station (24).

16. The radio base station in claim 13, wherein the communications are code division multiple access (CDMA) based,

wherein the one or more detectors (27-32) includes a CDMA code usage detector (28) for measuring CDMA code usage for the high speed shared radio channel during a predetermined time period.

17. The radio base station in claim 16, wherein the predetermined time period includes plural transmission time intervals (TTIs), the CDMA code usage detector (28) being configured to measure a number of TTIs a CDMA code is used for the high speed shared radio channel during the predetermined time period or a number of TTIs a set of the CDMA codes is used for the high speed shared radio channel during the predetermined time period.

18. The radio base station in claim 16, wherein the base station (24) is configured to send the CDMA code usage as a histogram to a radio network controller (16) or by a triggering condition based on the measurement.

19. The radio base station in claim 13, wherein the one or more detectors (27-32) includes a transport format usage detector (29) for measuring transport format usage for the high speed shared radio channel during a predetermined time period.

20. The radio base station in claim 13, wherein the one or more detectors (27-32) includes an active load monitor (30) for measuring a number of mobile radio users currently having data to transmit over the high speed shared channel in a base station buffer at a data transmission scheduling time for the high speed shared channel.

21. The radio base station in claim 13, wherein the one or more detectors (27-32) includes a buffer monitor (31) for measuring an amount of data being buffered per high speed shared channel user and determining a number of high speed shared channel transmission time intervals (TTIs) over a measurement period when the measured amount of buffered data reaches zero or is below a threshold.

22. The radio base station in claim 13, wherein the one or more detectors (27-32) includes an excess power monitor (32) for measuring a first power level actually used for transmission to a mobile radio user over the high speed shared channel, determining a second power level required for reliable transmission to the mobile radio user over the high speed shared channel, and determining the difference between the first and second power levels.

23. The radio base station in claim 13, wherein the first channels and the high speed shared channel are downlink radio channels from the mobile communications network to one or more of the mobile radios,

wherein the first radio channels include one or more of the following: one or more dedicated channels dedicated to a connection between the mobile communications network and one of the mobile radios, one or more common channels shared by the mobile radios, one or more control channels, and one or more broadcast channels.

24. The radio base station in claim 13, wherein one of the detectors (27) is configured to measure a transmission power for signals transmitted over the first radio

channels that does not include a measurement of a transmission power for signals transmitted over the high speed shared channel, and

wherein the high speed channel controller is configured to receive a power level for transmitting signals over the high speed shared channel determined based on the measured transmission power and to transmit over the high speed shared channel at the determined power.

25. The radio base station in claim 24, wherein the first and the high speed shared channels are downlink radio channels from the mobile communications network to one or more of the mobile radios,

wherein the first radio channels include: one or more dedicated channels dedicated to a connection between the mobile communications network and one of the mobile radios, one or more common channels shared by the mobile radios, one or more control channels, one or more broadcast channels.

26. The radio base station in claim 24, wherein the power allocated to the high speed shared channel combined with the power measured for the first radio channels does not exceed a predetermined maximum power associated with the base station.

27. Apparatus for use in a code division multiple access (CDMA) mobile communications network including one or more radio base stations that support radio communications with plural mobile radios, comprising:

a detector for measuring a CDMA code usage for the second radio channel during a predetermined time period;

a controller for determining whether CDMA codes currently allocated to the second radio channel are being efficiently used based on the measured CDMA code usage and for changing a current CDMA code allocation for the second radio channel if the CDMA codes currently allocated to the second radio channel are not being efficiently used.

28. The apparatus in claim 27, wherein the predetermined time period includes plural transmission time intervals (TTIs), the further configured to measure a number of

TTIs a CDMA code is used for the second radio channel during the predetermined time period or a number of TTIs a set of the CDMA codes is used for the second radio channel during the predetermined time period.

29. The apparatus in claim 28, wherein the CDMA code usage is reported as a histogram or by a triggering condition.

30. The apparatus in claim 28, wherein the detector is in a radio base station and the controller is in a radio network controller coupled to the radio base station.

31. Apparatus for use in a mobile communications network including one or more radio base stations that support radio communications with plural mobile radios, comprising:

a detector for measuring a transport format usage for the second radio channel during a predetermined time period;

a controller for determining whether a transport format currently allocated to the second radio channel is inefficient based on the measured transport format usage and for changing a current transport format for the second radio channel if the current transport format for the second radio channel is inefficient.

32. A radio base station for use in a mobile communications network that supports radio communications with plural mobile radios, wherein first radio channels and a high speed shared radio channel are associated with the radio base station, comprising:

an active load monitor for measuring a number of mobile radio users currently having data to transmit over the high speed shared channel in a base station buffer at a data transmission scheduling time for the high speed shared channel, and

a controller for providing the measured number to a radio resource controller for use in managing a load on the high speed shared channel.

33. The radio base station in claim 32, wherein the active load monitor is configured to average the measured number over a predetermined time interval.

34. A radio base station for use in a mobile communications network that supports radio communications with plural mobile radios, wherein first radio channels and a high speed shared radio channel are associated with the radio base station, comprising:

a buffer monitor for measuring an amount of data being buffered per high speed shared channel user and determining a number of high speed shared channel transmission time intervals (TTIs) over a measurement period when the measured amount of buffered data reaches zero or is below a threshold, and

a controller for providing the measured number to a radio resource controller for use in configuring the high speed shared channel.

35. A radio base station for use in a mobile communications network that supports radio communications with plural mobile radios, wherein first radio channels and a high speed shared radio channel are associated with the radio base station, comprising:

an excess power monitor for measuring a first power level actually used for transmission to a mobile radio user over the high speed shared channel, determining a second power level required for reliable transmission to the mobile radio user over the high speed shared channel, and determining the difference between the first and second power levels, and

a controller for providing the difference to a radio resource controller for use in allocating resources associated with the high speed shared channel.

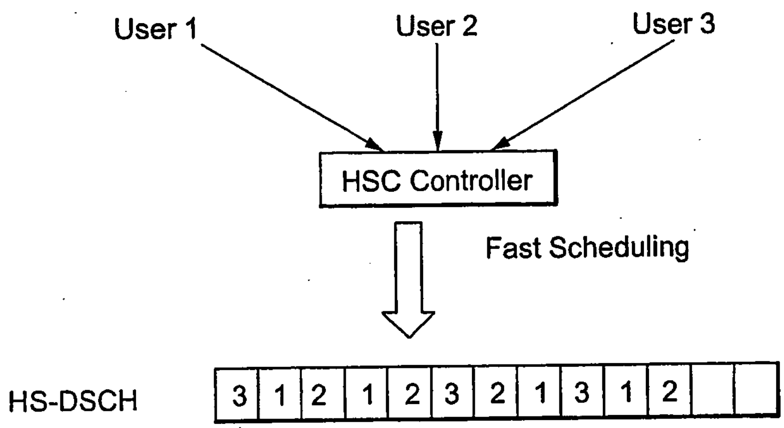

User 1
User 2
User 3
HSC Controller
Fast Scheduling
HS-DSCH
3 1 2 1 2 3 2 1 3 1 2

Fig. 1

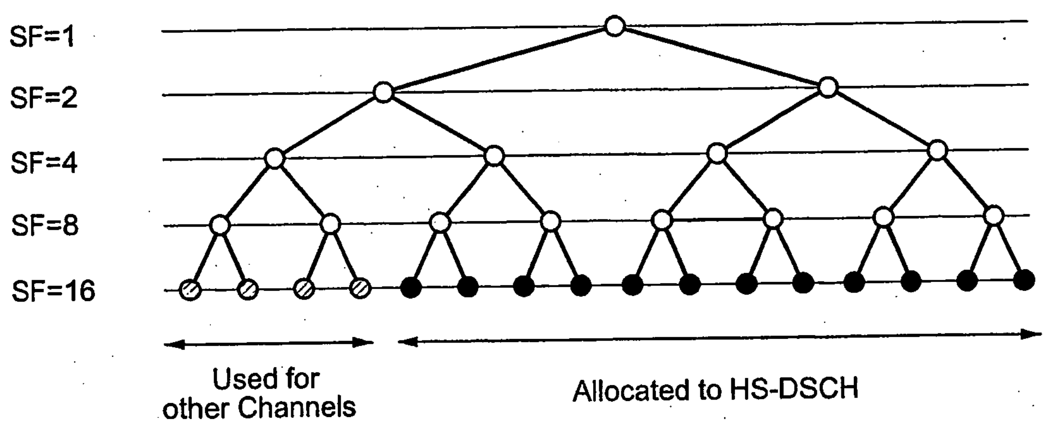
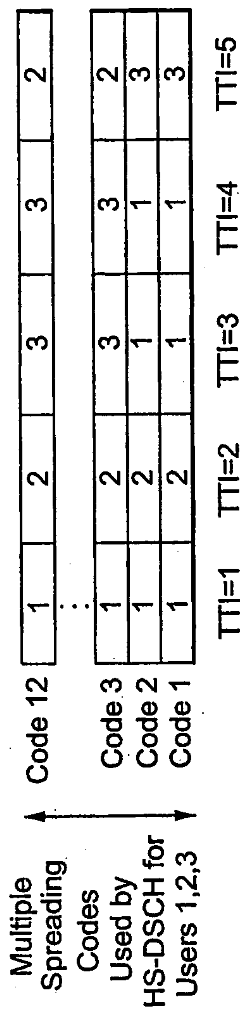
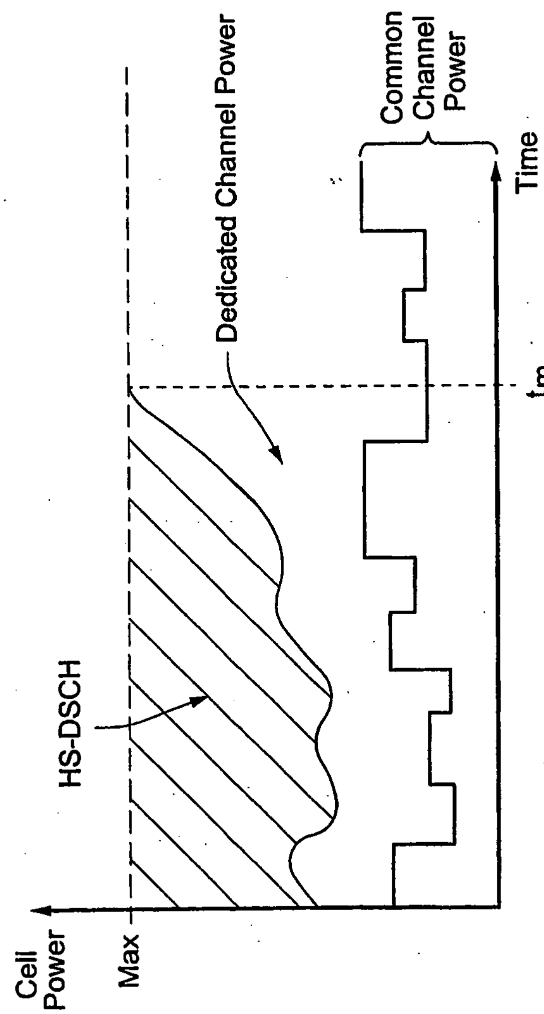

SF=1
SF=2
SF=4
SF=8
SF=16
Used for other Channels
Allocated to HS-DSCH

Fig. 2



Multiple Spreading Codes Used by HS-DSCH for Users 1,2,3
Code 12
Code 3
Code 2
Code 1
TTI=1
TTI=2
TTI=3
TTI=4
TTI=5

Fig. 3



Cell Power
Max
HS-DSCH
Dedicated Channel Power
Common Channel Power
Time
t_m

Fig. 4

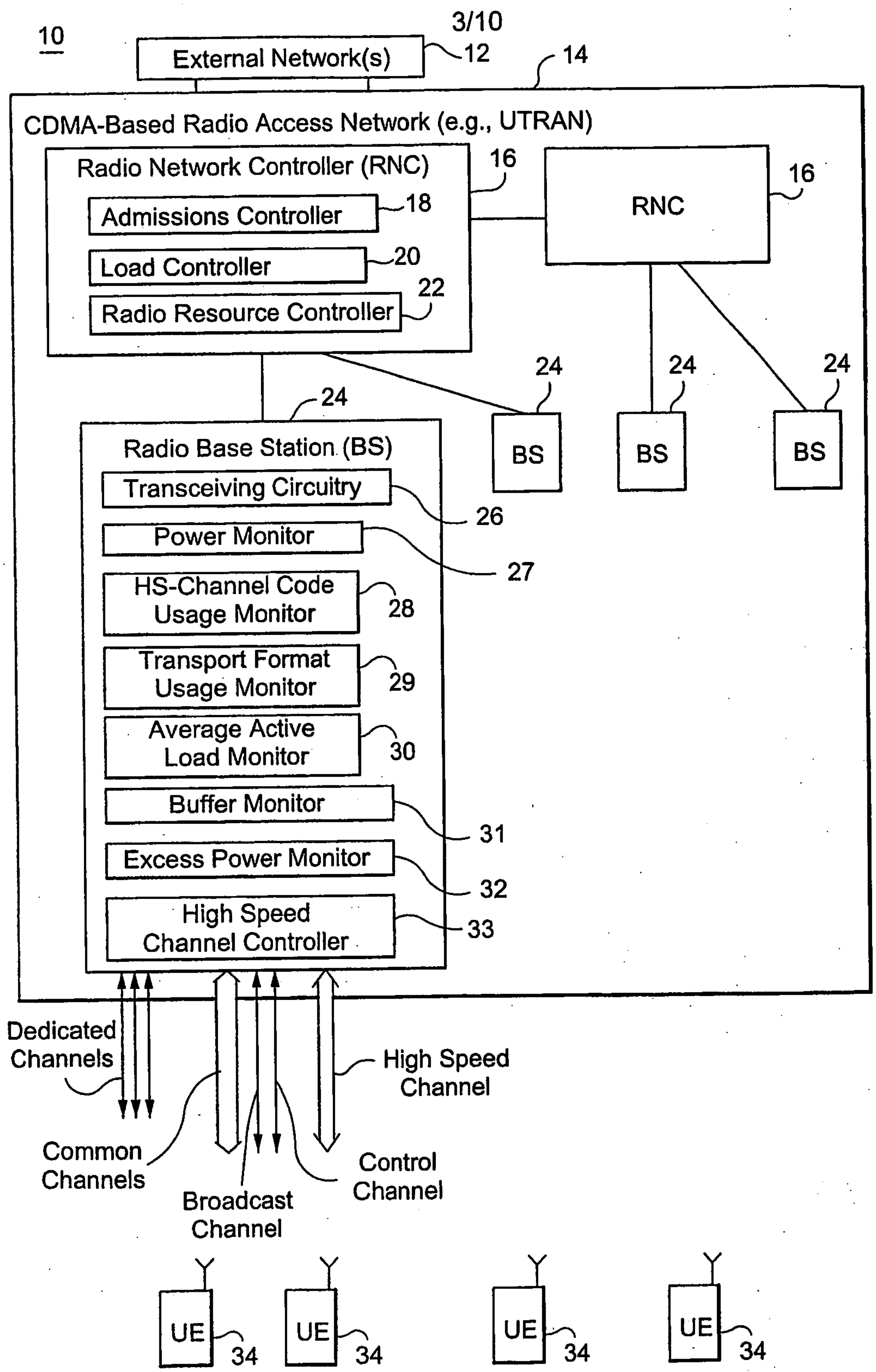

10
External Network(s)
12
14
CDMA-Based Radio Access Network (e.g., UTRAN)
Radio Network Controller (RNC)
16
Admissions Controller
18
Load Controller
20
Radio Resource Controller
22
RNC
16
24
BS
24
BS
24
BS
24
Radio Base Station (BS)
Transceiving Circuitry
26
Power Monitor
27
HS-Channel Code Usage Monitor
28
Transport Format Usage Monitor
29
Average Active Load Monitor
30
Buffer Monitor
31
Excess Power Monitor
32
High Speed Channel Controller
33
Dedicated Channels
High Speed Channel
Common Channels
Broadcast Channel
Control Channel
UE
34
UE
34
UE
34
UE
34

Fig. 5

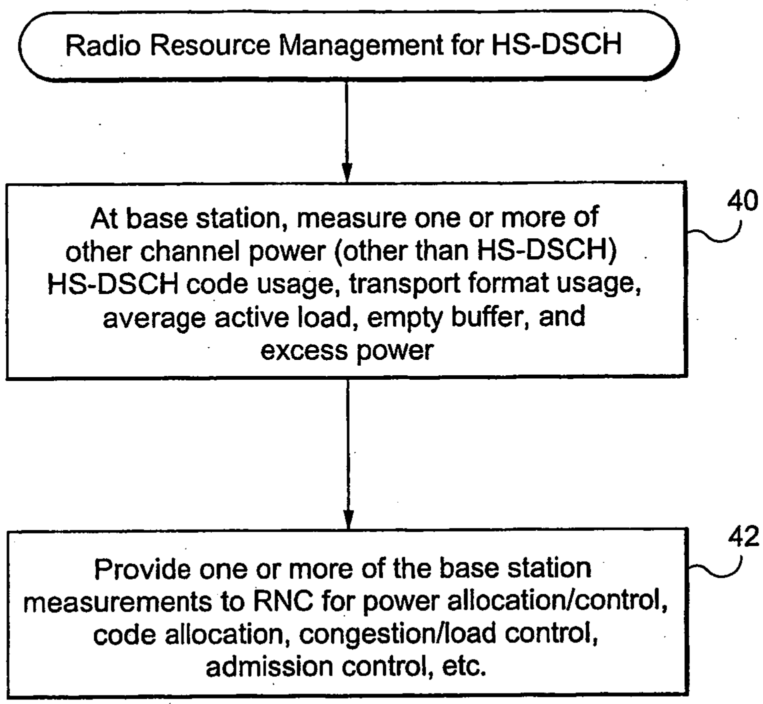

Radio Resource Management for HS-DSCH
At base station, measure one or more of other channel power (other than HS-DSCH) HS-DSCH code usage, transport format usage, average active load, empty buffer, and excess power
40
Provide one or more of the base station measurements to RNC for power allocation/control, code allocation, congestion/load control, admission control, etc.
42

Fig. 6

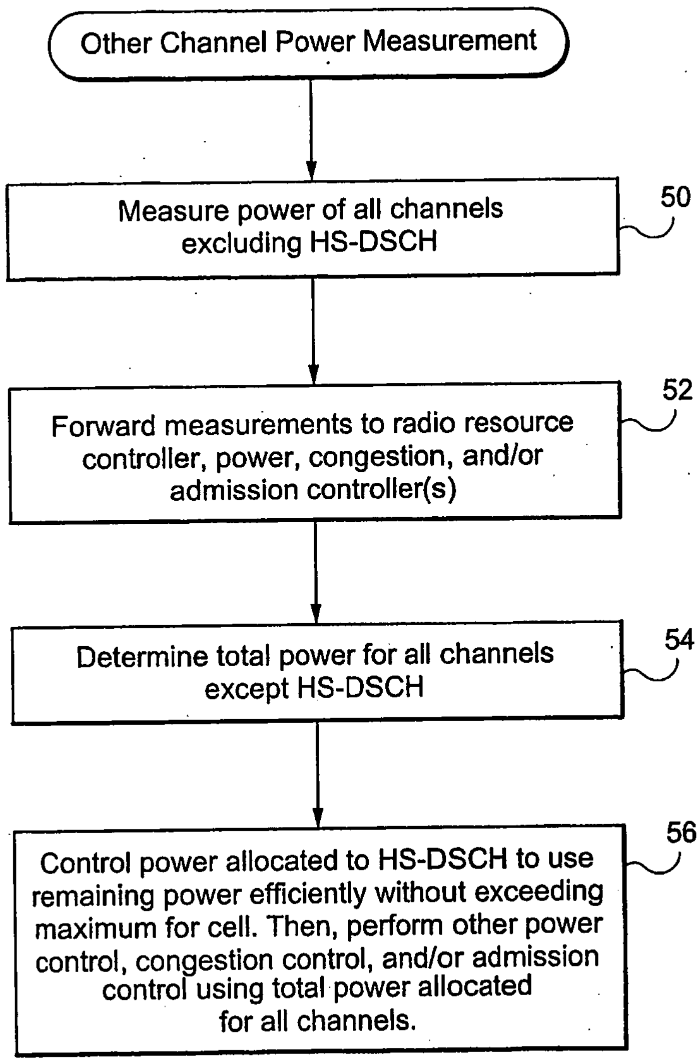

Other Channel Power Measurement
Measure power of all channels excluding HS-DSCH
50
Forward measurements to radio resource controller, power, congestion, and/or admission controller(s)
52
Determine total power for all channels except HS-DSCH
54
Control power allocated to HS-DSCH to use remaining power efficiently without exceeding maximum for cell. Then, perform other power control, congestion control, and/or admission control using total power allocated for all channels.
56

Fig. 7

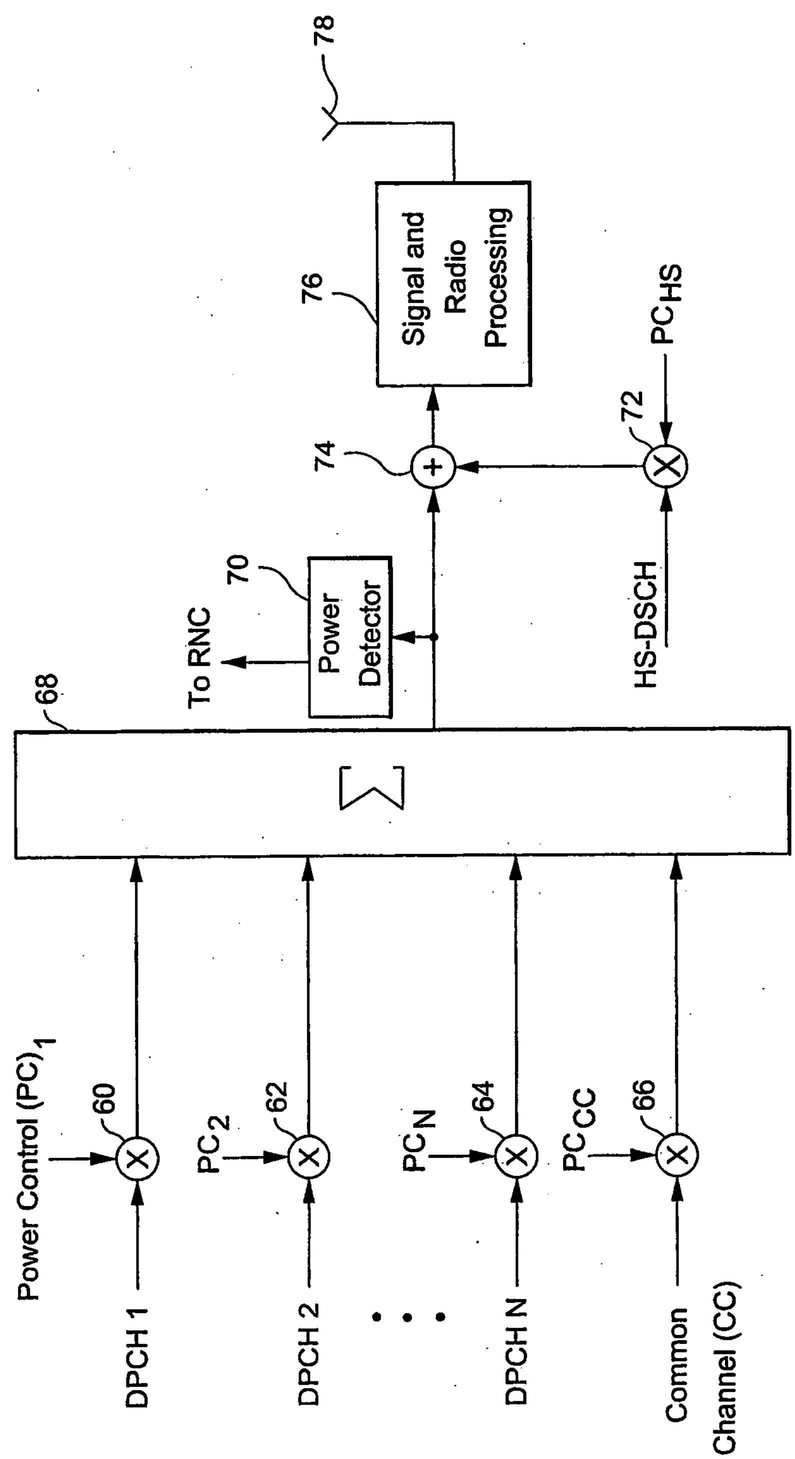

DPCH 1
Power Control (PC)1
60
DPCH 2
PC2
62
DPCH N
PCN
64
Common Channel (CC)
PCCC
66
68
Σ
To RNC
70
Power Detector
74
72
HS-DSCH
PCHS
76
Signal and Radio Processing
78

Fig. 8

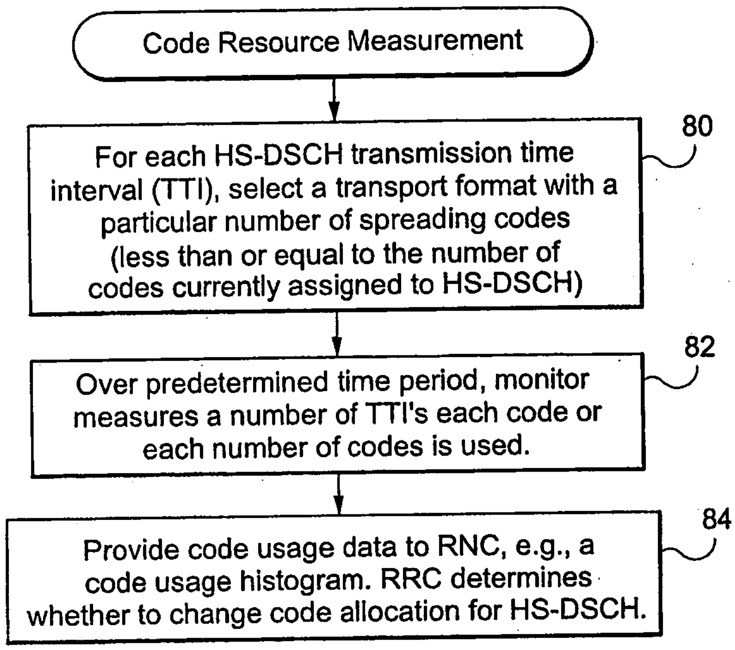


Fig. 9

TTI \ Code	1	2	3	4	5	6	7	8	9	10	11	12
0	X	X	X	X	X	X						
1	X	X			X	X	X	X	X	X		
2					X	X	X	X	X	X		
3	X	X			X	X						
⋮												
3	X	X	X									

Fig. 10

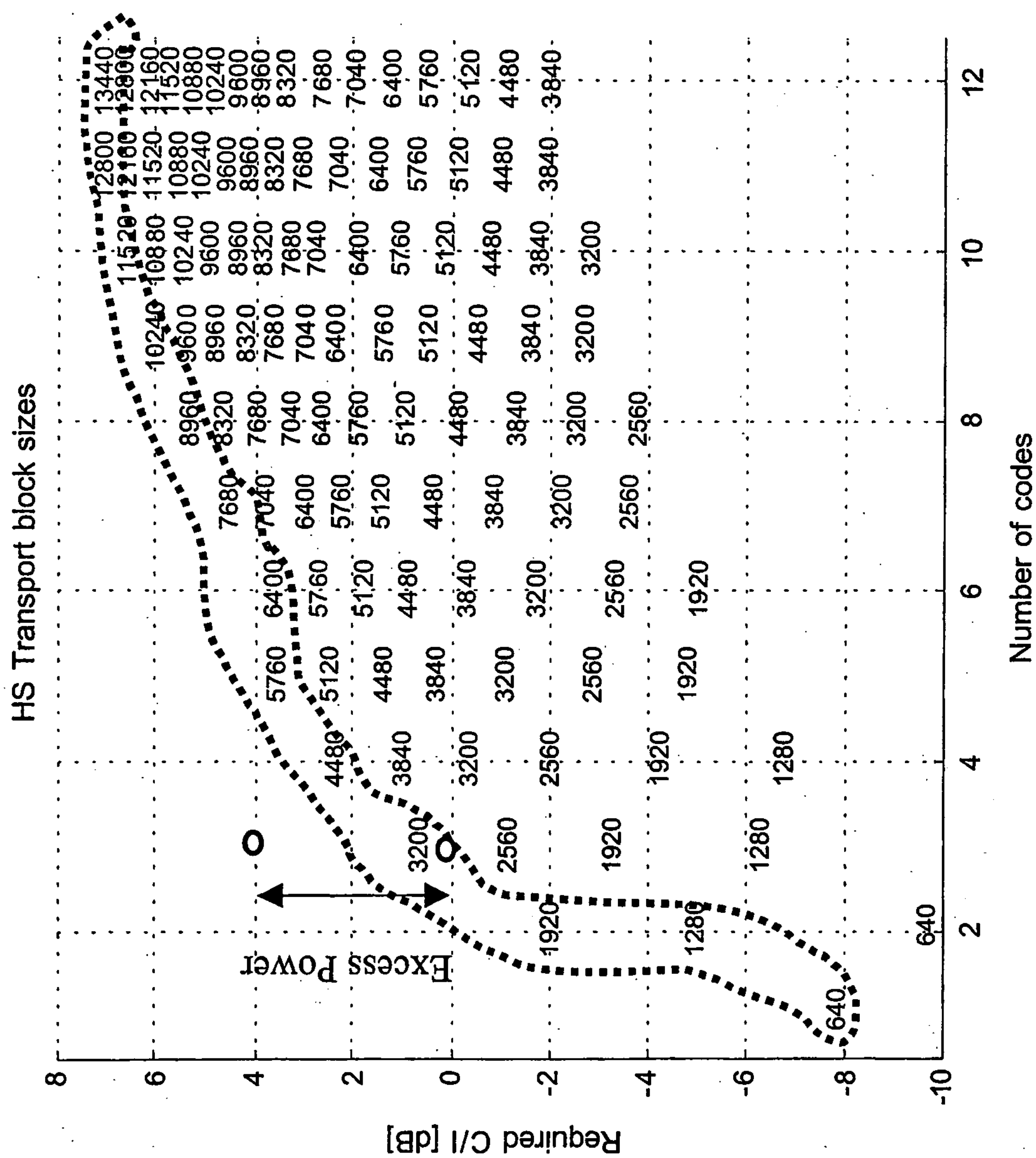

HS Transport block sizes
Number of codes
Required C/I [dB]
Excess Power

Fig. 11

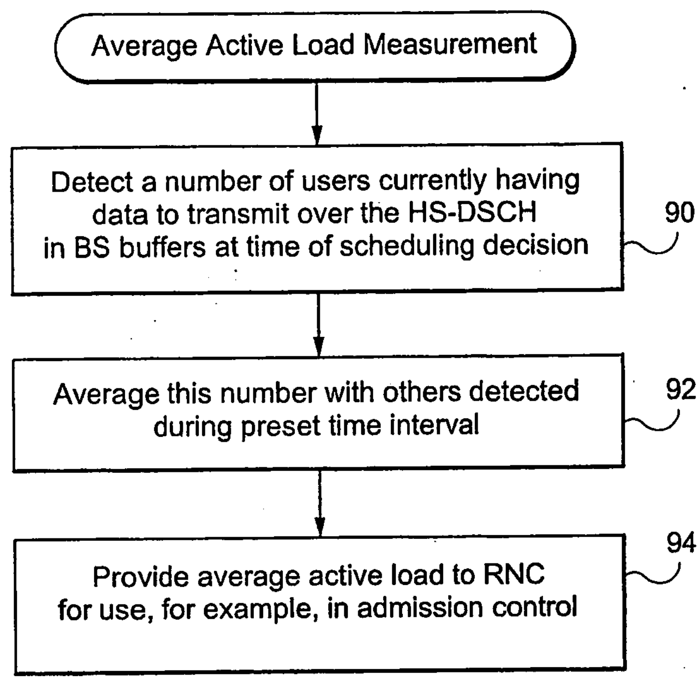

Average Active Load Measurement
Detect a number of users currently having data to transmit over the HS-DSCH in BS buffers at time of scheduling decision
90
Average this number with others detected during preset time interval
92
Provide average active load to RNC for use, for example, in admission control
94

Fig. 12

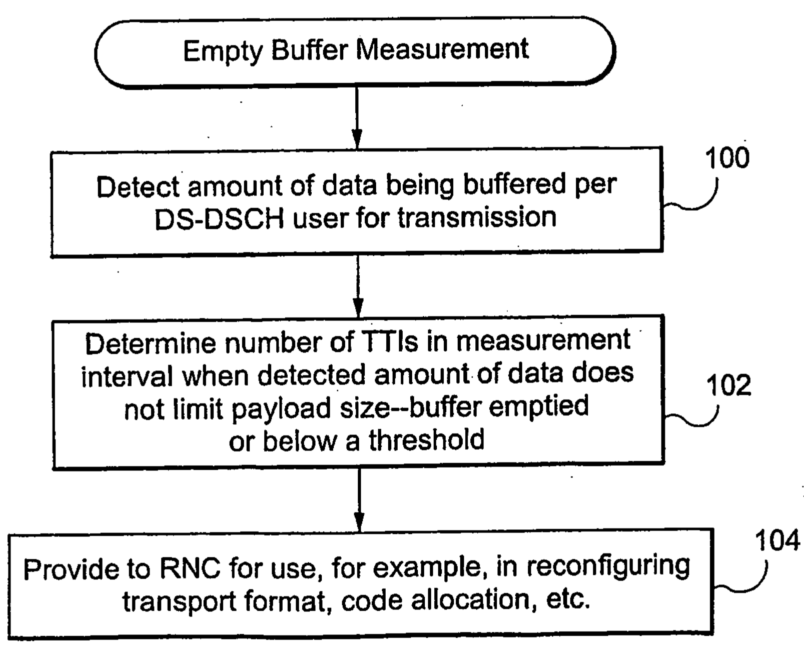

Empty Buffer Measurement
Detect amount of data being buffered per DS-DSCH user for transmission
100
Determine number of TTIs in measurement interval when detected amount of data does not limit payload size--buffer emptied or below a threshold
102
Provide to RNC for use, for example, in reconfiguring transport format, code allocation, etc.
104

Fig. 13

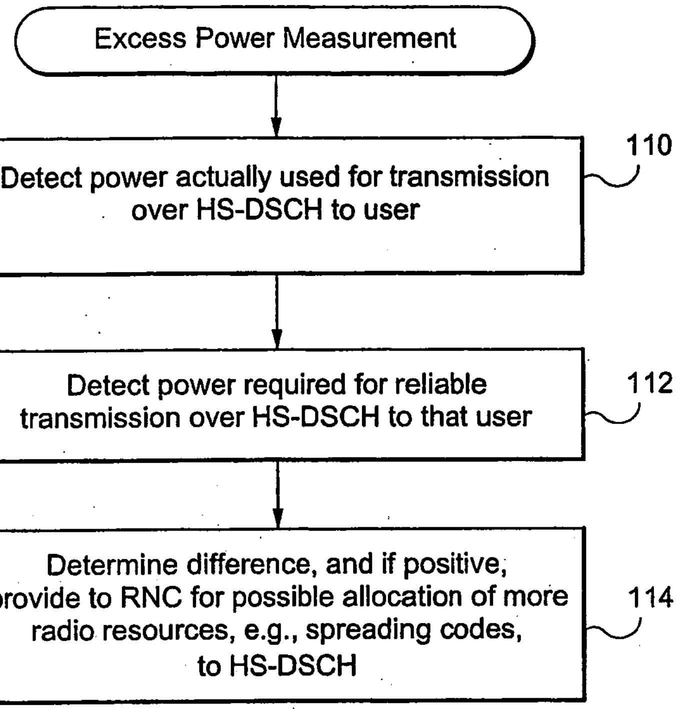

Excess Power Measurement
Detect power actually used for transmission over HS-DSCH to user
110
Detect power required for reliable transmission over HS-DSCH to that user
112
Determine difference, and if positive, provide to RNC for possible allocation of more radio resources, e.g., spreading codes, to HS-DSCH
114

Fig. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 03/00694

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/005, H04B 7/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H04L, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MOULSLEY, T.J, et al. "Performance of UMTS high speed downlink packet access for data streaming applications" In: Third International Conference on 3G Mobile Mobile Communication Technologies, 2002. (Conf. Publ. No. 489), 8 - 10 May 2002, pages 302 - 307, INSPEC AN: 7625913, see abstract --	1-35
P,X	WO 2085059 A1 (NOKIA CORPORATION), 24 October 2002 (24.10.02), page 4, line 15 - page 5, line 11 --	1-35

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 July 2003	23 -07- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Markus Stålö /OGU Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 03/00694

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	TSG RAN WG1, CHANGE REQUEST, 25.215 CR 134 V 5.2.0: "Non-HSDPA power measurement" In: 3GPP TSG-RAN meeting #31, Tokyo, Japan, 18 - 21 February 2003, pages 1 - 3 [on line], [retrieved on 2003-07-17] Retrieved from the Internet: <URL: http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_19/Docs/PDF/RP-030081.pdf>, see page 1, sections "Reason for change" and "Consequences if not approved" --	1-35
P,X	RAN WG3, CHANGE REQUEST, 25.433 CR 801: "HS-DSCH: Addition of non HS-DSCH power measurement". In: 3GPP TSG-RAN3 Meeting #34, Sophia Antipolis, France, 17 - 21 February 2003, pages 1 - 18 [on line], [retrieved on 2003-07-17] Retrieved from the Internet: URL: http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_19/Docs/PDF/RP-030081.pdf>, see page 1, sections "Reason for change" and "Consequences if not approved" -- --------	1-35

INTERNATIONAL SEARCH REPORT
Information on patent family members

29/06/03

International application No.
PCT/SE 03/00694

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2085059 A1	24/10/02	NONE	

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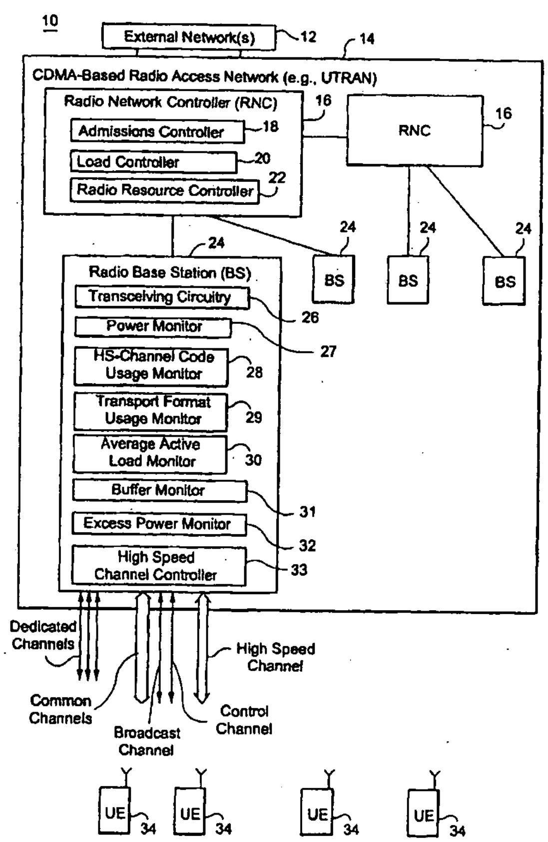
(74) Agent: MAGNUSSON, Monica; Ericsson AB, Patent Unit Radio Networks, S-164 80 Stockholm (SE).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD,

[Continued on next page]

(54) Title: RADIO RESOURCE MANAGEMENT FOR A HIGH SPEED SHARED CHANNEL



(57) Abstract: Radio resources like spreading codes and transmission power are optimally allocated to various different types of radio channels supported in the cell including a specialized channel like a high-speed shared channel. One or more measurements made at the base station are provided to the radio resource manager. Such measurements include other-channel power, high speed shared channel code usage, high speed shared channel transport format usage, average active load on the high speed shared channel, empty buffer, excess power, and similar parameters that relate to a high speed shared channel. One or more of these reported measurements may then be used to access, allocate, and/or regulate resources associated with the base station's cell.

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SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2003/000694

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/005, H04Q 7/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H04L, H04Q

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X	PARKVALL, S. et al: "Evolving WCDMA for Improved High Speed Mobile Internet". In: FUTURE TELECOMMUNICATIONS CONFERENCE '2001, 28-30 November 2001, Beijing, Kina, See chapter IV, A., "Mixed service principles and capacity results"	1-35
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A	3GPP TS 25.308 V5.2.0 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (Release 5), March 2002, see chapter 10	1-35
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2004	16 -10- 2003

Name and mailing address of the ISA/	Authorized officer
Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Markus Stålö /OGU Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

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PCT/SE 2003/000694

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International application No.
PCT/SE 03/00694

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2085059 A1	24/10/02	NONE	